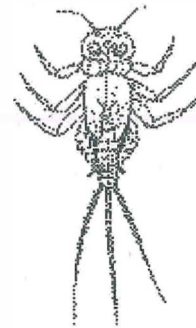
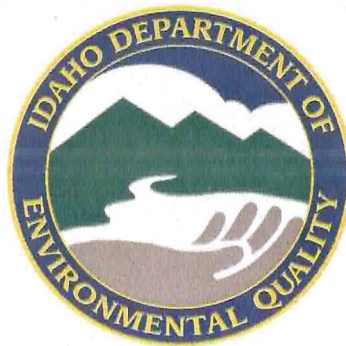
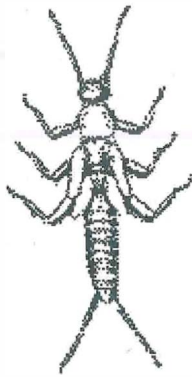


Temperature Preferences and Tolerances for 137 Common Idaho Macroinvertebrate Taxa



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Stream temperature may effect macroinvertebrate taxa and community structure through changes in fecundity, growth rates, biomass, metabolism, and egg and larval diapause. The thermal regime of a stream can be influenced by a number of environmental factors. On the reach scale factors such as width to depth ratio, canopy closure, ground water inflow, percent pools, and gradient can all play a significant role in stream temperature. On the landscape scale stream temperature can be influenced by latitude/longitude, aspect, elevation, climate, and drainage area. Knowledge of stream temperature and the effect of land management decisions on stream temperature are needed if managers are to make good decisions regarding management actions. Many states in the west are in the process of determining stream temperature through the use of instream incremental data loggers. Although these data loggers are not prohibitively expensive they do require multiple visits to a stream which can be difficult if the stream is located in a remote area. The need for a tool to determine a stream's thermal regime from biological data has been identified by many state land management agencies. Currently land managers rely on professional judgement, conventional wisdom, consensus with other managers, and limited experimental data to determine macroinvertebrate temperature preference and from this information make an estimate as to the thermal regime of a stream. Because of the potential of stream temperature to play a dominant role in community structure it is important for scientists and land managers to understand taxa response to temperature if they are to correctly interpret biologic data as it relates to impairment. In this paper I have attempted to determine temperature preferences and tolerance for the most common taxa found in Idaho streams using several thousand instantaneous temperature measurements from water bodies throughout Idaho.

Methods

The Idaho Department of Environmental Quality has had an active bioassessment program since 1993. During this time 4148 sites on 1st through 3rd order streams have been monitored in 79 sub-basins throughout Idaho. Ecoregions of the sites included Snake River Basin/High Desert (980 sites), Wyoming Basin (57 sites), Northern Rockies (2055 sites), Middle Rockies (322 sites), Columbia Basin (96 sites), Northern Basin and Range (434 sites), and Blue Mountains (136 sites). IDEQ's bioassessment program

collects macroinvertebrate, fish, habitat and limited physical/chemical parameters. Sites were chosen to represent typical sections of a stream. The total reach length of the sites were either 20 times the general stream width or 100 meters, whichever was greater. Stream flow is strongly unimodal in nearly all of the streams as a result of spring snowmelt with peak flows occurring from March to the end of June. Land use within the state is highly variable. Southern Idaho is predominately rangeland with irrigate agriculture near major streams and rivers. Northern Idaho is mainly forested land with silviculture and mining activities. Precipitation ranges from 25 cm/yr in southern Idaho to 190 cm/yr in the higher elevations of northern Idaho. Elevation of the sites ranged from 230 metres to 2700 metres. All sites with corresponding instantaneous temperature data were used regardless of perceived level of impairment.

Macroinvertebrate Collection

Benthic macroinvertebrate samples were collected in three separate riffles within the stream reach with a total sampling area of 0.26m² using a Hess sampler equipped with 500µm mesh nitex netting. The sampling transects were typically located near the bottom, middle, and top of the reach. Samples from each riffle were preserved separately in 70% ethanol. If the sample had a considerable amount of organic matter or fine sediment the alcohol was decanted off after 24 hours and fresh 70% ethanol was added to the sample. The three samples from each site were later combined and identified to the lowest possible taxonomic level, typically genus or species. The composited sample was sub-sampled until a minimum of 500 individual had been enumerated or until the entire sample was counted.

Instantaneous Temperature Measurements

Stream water temperature is typically taken near the bottom of the sample reach in conjunction with the macroinvertebrate sample collection using a standard alcohol thermometer. The reading is recorded on field forms and entered into IDEQ's database.

Results

Determination of Temperature Preference and Tolerance

All taxa that did not occur in at least 2% of the 2607 samples were excluded from the analysis. The exclusion of the uncommon taxa resulted in selection of 289 out of the original 1163 taxa in the database.

In order to have a sample size sufficient to develop a preference curve there needed to be a minimum number of sites at any given temperature, therefore, I decided that a minimum of 10 samples were needed to perform the analysis. This step truncated the temperature range from 1°C – 26°C to 4°C - 25°C. I then rounded the instantaneous temperature measurements to the nearest 1 °C increment. Most of the instantaneous readings were already in whole degrees so this was a minor adjustment.

I then calculated the proportion of time the taxa occurred at each temperature. The resulting proportions were plotted and a LOWESS smooth function was applied to the data. A visual inspection was made of each of the taxa as they related to temperature. Taxa that had exhibit little response to temperature or had considerable amount of scatter were excluded. A distinct relationship to temperature had to exist to the eye for it to be considered as a temperature indicator. This process reduced the taxa list to 137 taxa. The weighted mean and weighted standard deviation were calculated for each of these indicator taxa. The weighted mean equates to the optimal temperature or temperature preference for the taxa. The weighted standard deviation is the tolerance to different temperatures. The weighted mean and weighted standard deviation as well as a graphical representation of these values is presented in Appendix A. The taxa are presented by order and then alphabetical within order. The graphical representation shows the mean as

well as one standard deviation above and below the mean. One can assume that 66% of the total occurrence of the individual taxa would be within the temperature range depicted by the horizontal line. Similar information is present in Appendix B, but arranged in ascending temperature preferences.

One of Idaho's water quality criteria for cold water biota is a daily average stream temperature not to exceed 19°C. With this in mind I set out to determine which taxa would be least likely to occur if the stream exceeded this temperature. I queried the 137 taxa and created a list of the taxa that occurred less than 5% of the time in sites where the stream temperature exceeded 19°C. The resulting 44 cold water obligate taxa list can be found in Appendix C.

Appendix A.

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Macroinvertebrate Temperature Preferences and Tolerances

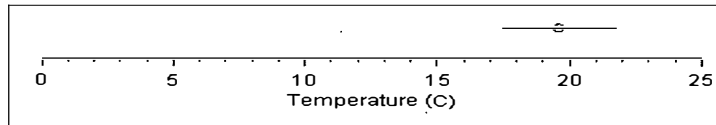
Amphipoda

Hyaella azteca

Taxa # 446

Temp Preference 19.59

Tolerance 2.14



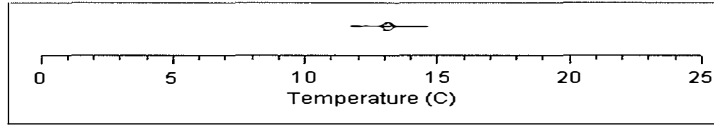
Macroinvertebrate Temperature Preferences and Tolerances

Chironomidae (family)

Brillia sp.

Taxa # 322

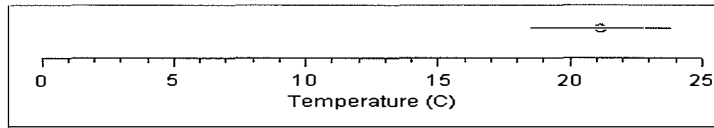
Temp Preference 13.15
Tolerance 1.5



Cricotopus bicinctus gr.

Taxa # 334

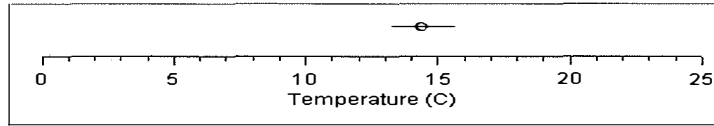
Temp Preference 21.18
Tolerance 2.68



Cricotopus sp.

Taxa # 333

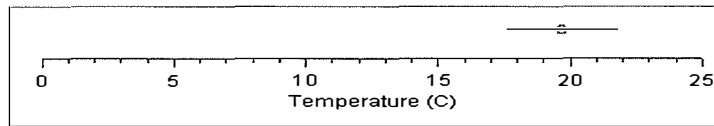
Temp Preference 14.39
Tolerance 1.19



Cricotopus trifascia gr.

Taxa # 339

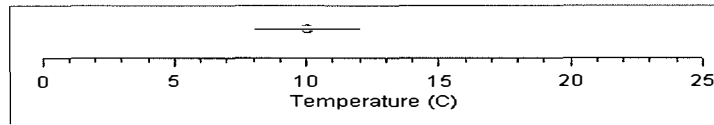
Temp Preference 19.68
Tolerance 2.13



Diamesa sp.

Taxa # 341

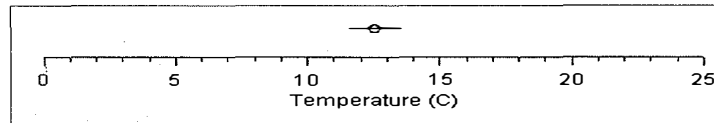
Temp Preference 1
Tolerance 1.9



Eukiefferiella claripennis gr.

Taxa # 348

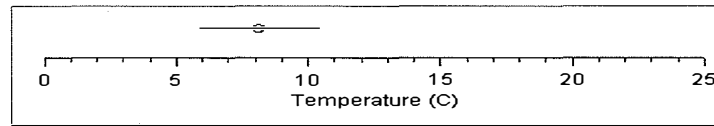
Temp Preference 12.5
Tolerance 1



Heleniella sp.

Taxa # 352

Temp Preference 8.1
Tolerance 2.2



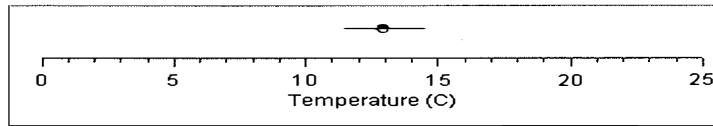
Macroinvertebrate Temperature Preferences and Tolerances

Pagastia sp.

Taxa # 373

Temp Preference 12.91

Tolerance 1.54

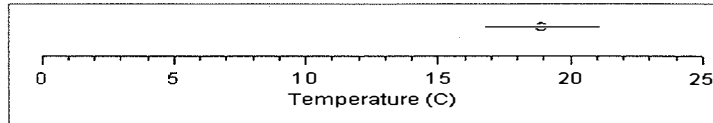


Pentaneura sp.

Taxa # 384

Temp Preference 18.9

Tolerance 2.19

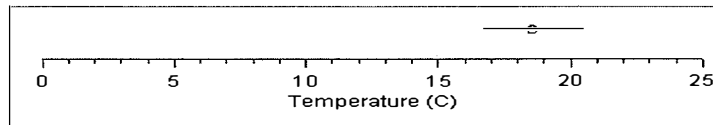


Polypedilum sp.

Taxa # 386

Temp Preference 18.55

Tolerance 1.86

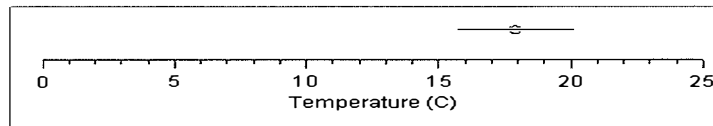


Rheotanytarsus sp.

Taxa # 401

Temp Preference 17.89

Tolerance 2.2

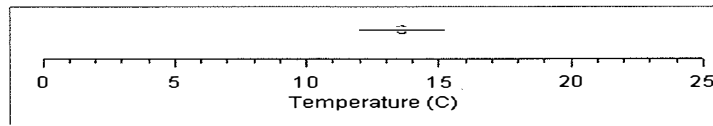


Stempellinella sp.

Taxa # 403

Temp Preference 13.58

Tolerance 1.63

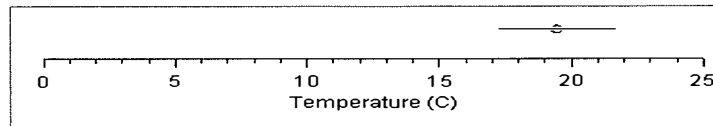


Tanytarsus sp.

Taxa # 408

Temp Preference 19.46

Tolerance 2.21

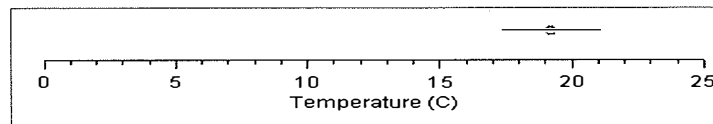


Thienemannimyia gr. sp.

Taxa # 1041

Temp Preference 19.19

Tolerance 1.9



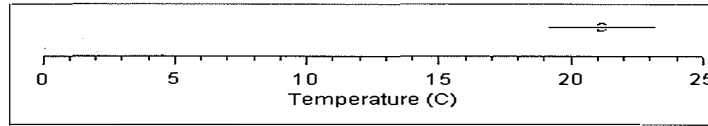
Macroinvertebrate Temperature Preferences and Tolerances

Coleoptera

Brychius sp.

Taxa # 536

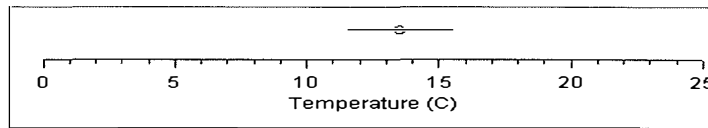
Temp Preference 21.15
Tolerance 2.06



Cleptelmis sp.

Taxa # 259

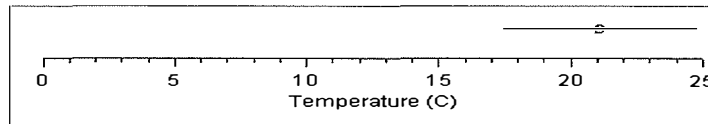
Temp Preference 13.53
Tolerance 2



Dubiraphia sp.

Taxa # 261

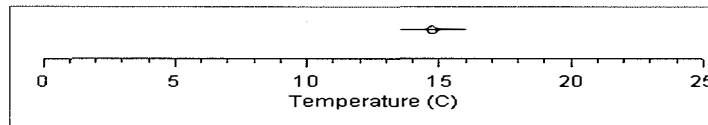
Temp Preference 21.08
Tolerance 3.67



Dytiscidae

Taxa # 251

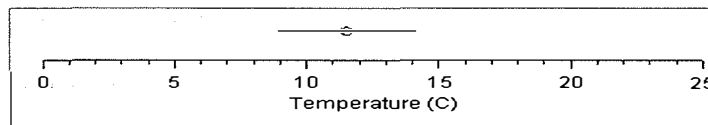
Temp Preference 14.76
Tolerance 1.27



Heterlimnius corpulentus

Taxa # 263

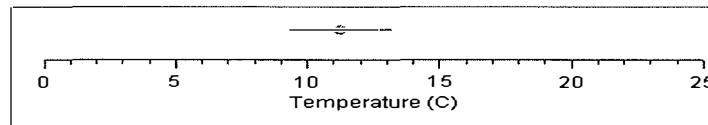
Temp Preference 11.51
Tolerance 2.66



Heterlimnius sp.

Taxa # 262

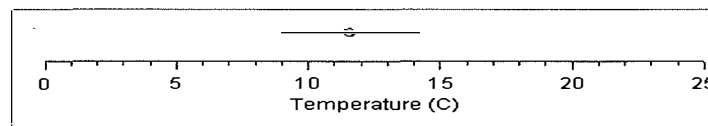
Temp Preference 11.24
Tolerance 1.93



Lara sp.

Taxa # 596

Temp Preference 11.56
Tolerance 2.64



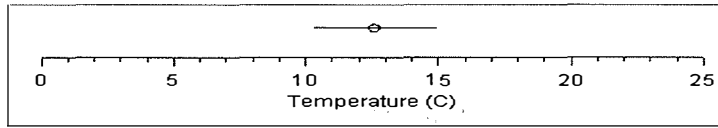
Macroinvertebrate Temperature Preferences and Tolerances

Narpus sp.

Taxa # 265

Temp Preference 12.58

Tolerance 2.32

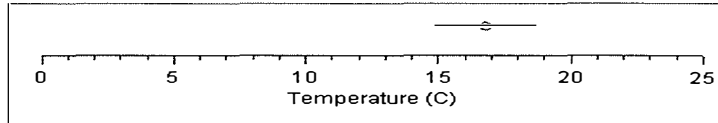


Optioservus quadrimaculatus

Taxa # 268

Temp Preference 16.78

Tolerance 1.92

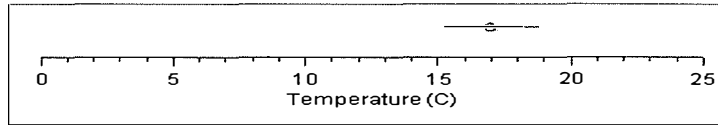


Optioservus sp.

Taxa # 267

Temp Preference 16.95

Tolerance 1.79

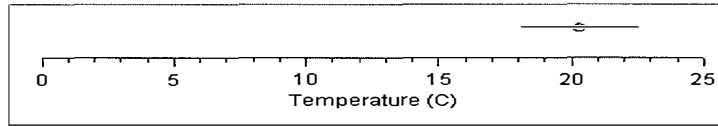


Psephenus sp.

Taxa # 674

Temp Preference 20.29

Tolerance 2.25

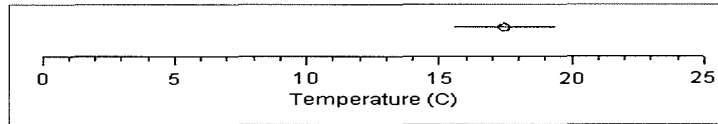


Zaitzevia sp.

Taxa # 271

Temp Preference 17.44

Tolerance 1.88



Macroinvertebrate Temperature Preferences and Tolerances

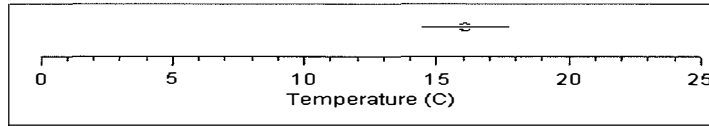
Diptera

Antocha sp.

Taxa # 284

Temp Preference 16.07

Tolerance 1.63

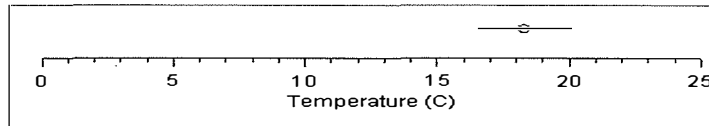


Atherix sp.

Taxa # 311

Temp Preference 18.31

Tolerance 1.81

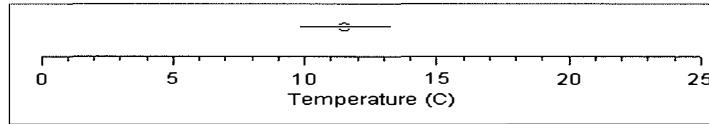


Chelifera sp.

Taxa # 306

Temp Preference 11.5

Tolerance 1.72

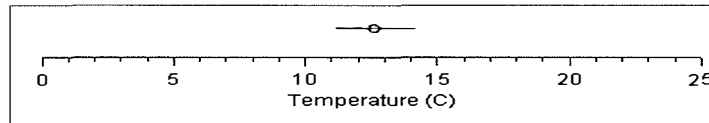


Clinocera sp.

Taxa # 307

Temp Preference 12.61

Tolerance 1.53

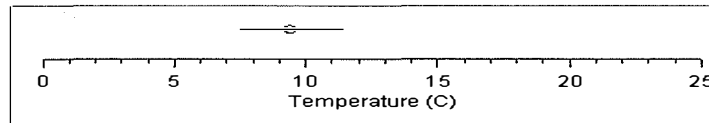


Glutops sp.

Taxa # 316

Temp Preference 9.4

Tolerance 1.97

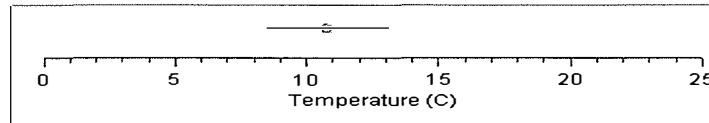


Hesperoconopa sp.

Taxa # 287

Temp Preference 10.76

Tolerance 2.34

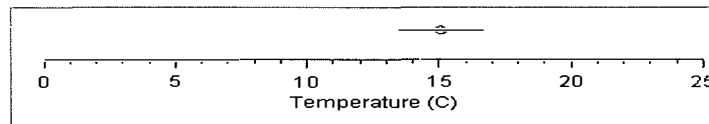


Hexatoma sp.

Taxa # 286

Temp Preference 15.06

Tolerance 1.64

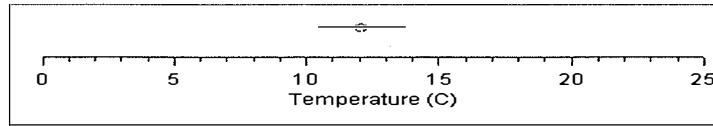


Macroinvertebrate Temperature Preferences and Tolerances

Limnophila sp.

Taxa # 283

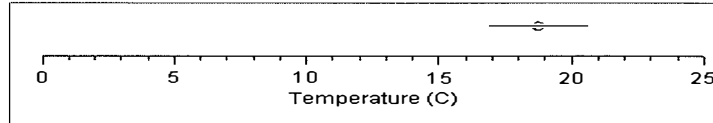
Temp Preference 12.06
Tolerance 1.66



Limnophora sp.

Taxa # 646

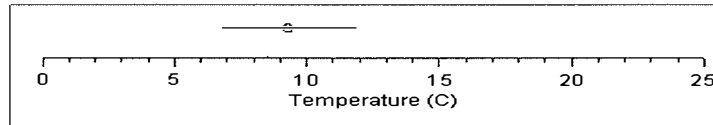
Temp Preference 18.74
Tolerance 1.87



Oreogeton sp.

Taxa # 580

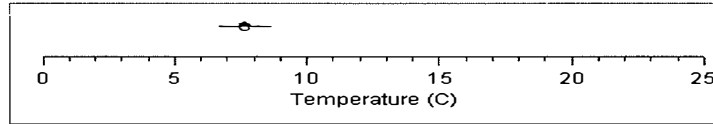
Temp Preference 9.29
Tolerance 2.56



Prosimulium sp.

Taxa # 302

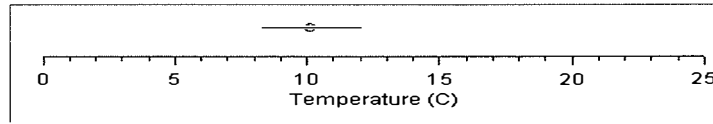
Temp Preference 7.65
Tolerance 1.04



Rhabdomastix sp.

Taxa # 615

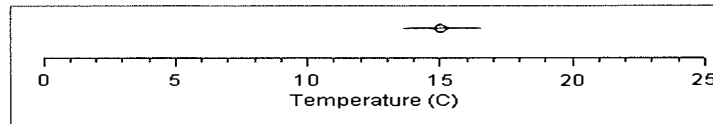
Temp Preference 10.12
Tolerance 1.9



Simulium sp.

Taxa # 303

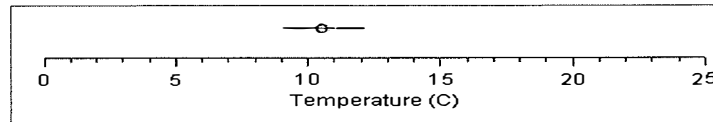
Temp Preference 15.04
Tolerance 1.49



Wiedemannia sp.

Taxa # 310

Temp Preference 10.53
Tolerance 1.55



Macroinvertebrate Temperature Preferences and Tolerances

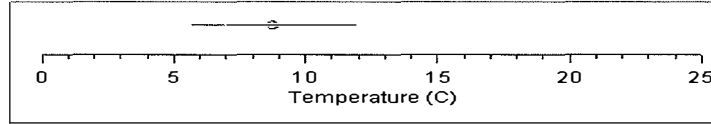
Ephemeroptera

Ameletus similor

Taxa # 693

Temp Preference 8.74

Tolerance 3.12

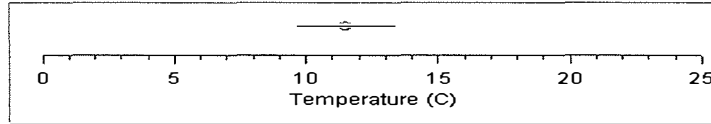


Ameletus sp.

Taxa # 13

Temp Preference 11.5

Tolerance 1.84

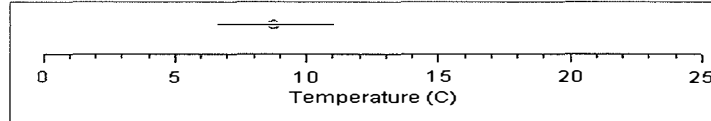


Baetis bicaudatus

Taxa # 18

Temp Preference 8.76

Tolerance 2.22

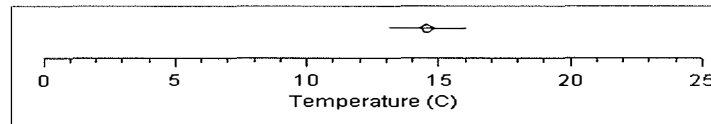


Baetis tricaudatus

Taxa # 20

Temp Preference 14.55

Tolerance 1.5

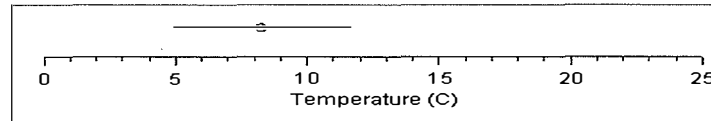


Caudatella hystrix

Taxa # 42

Temp Preference 8.25

Tolerance 3.34

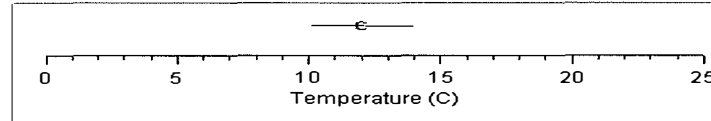


Caudatella sp.

Taxa # 39

Temp Preference 12

Tolerance 1.92

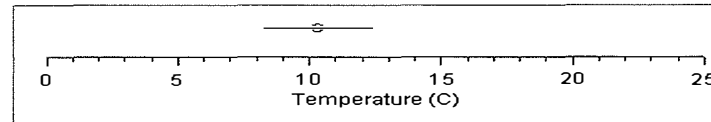


Cinygmula sp.

Taxa # 26

Temp Preference 10.31

Tolerance 2.06



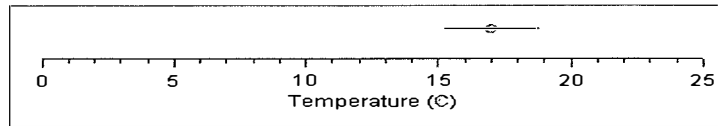
Macroinvertebrate Temperature Preferences and Tolerances

Dipheter hageni

Taxa # 679

Temp Preference 17

Tolerance 1.79

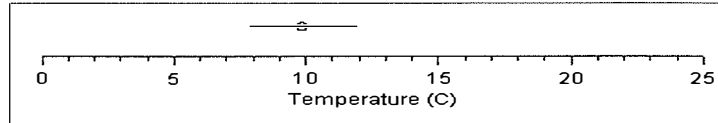


Drunella coloradensis

Taxa # 44

Temp Preference 9.86

Tolerance 2.07

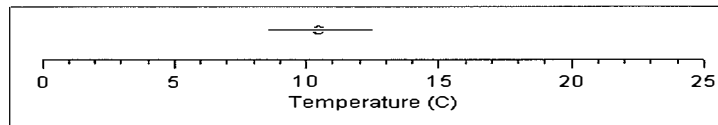


Drunella doddsi

Taxa # 43

Temp Preference 10.47

Tolerance 1.96

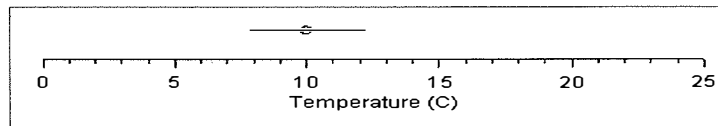


Drunella flavilinea/coloradensis

Taxa # 622

Temp Preference 9.98

Tolerance 2.17

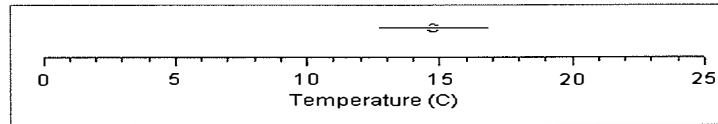


Drunella grandis

Taxa # 51

Temp Preference 14.74

Tolerance 2.07

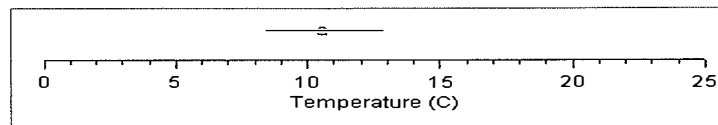


Drunella spinifera

Taxa # 48

Temp Preference 10.56

Tolerance 2.21

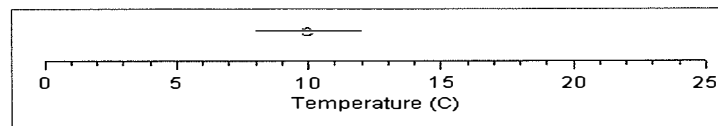


Epeorus (Ironopsis) sp.

Taxa # 27

Temp Preference 9.95

Tolerance 2

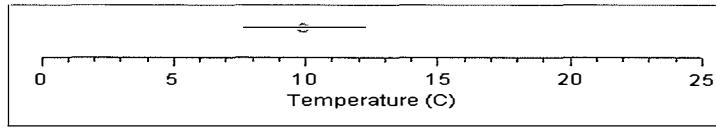


Macroinvertebrate Temperature Preferences and Tolerances

Epeorus deceptivus

Taxa # 29

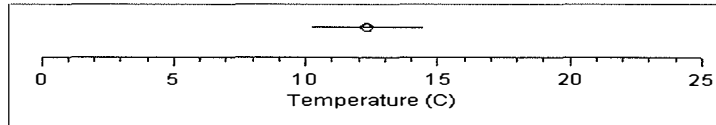
Temp Preference 9.9
Tolerance 2.31



Epeorus longimanus

Taxa # 31

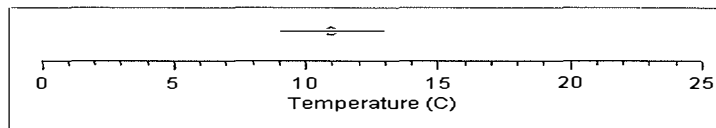
Temp Preference 12.32
Tolerance 2.1



Ephemerellidae

Taxa # 36

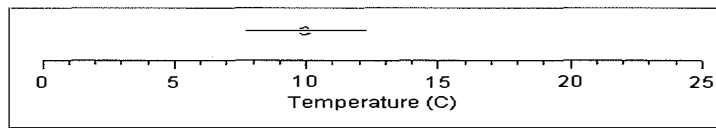
Temp Preference 10.97
Tolerance 1.97



Ironopsis grandis

Taxa # 32

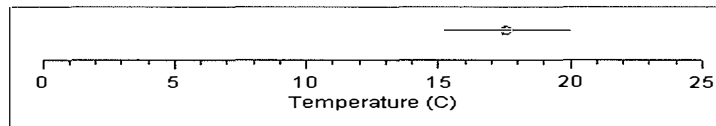
Temp Preference 9.95
Tolerance 2.3



Nixe criddlei

Taxa # 483

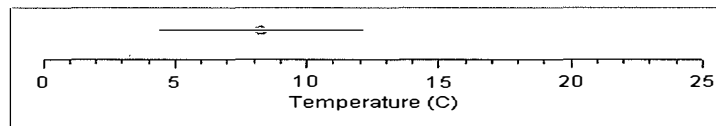
Temp Preference 17.57
Tolerance 2.37



Rhithrogena hageni

Taxa # 485

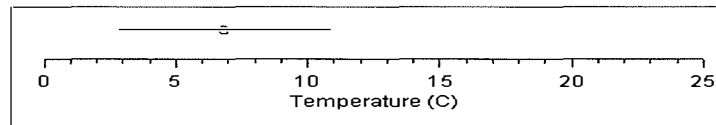
Temp Preference 8.25
Tolerance 3.86



Rhithrogena robusta

Taxa # 625

Temp Preference 6.84
Tolerance 4



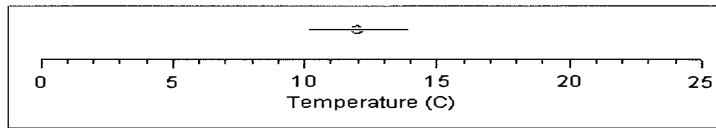
Macroinvertebrate Temperature Preferences and Tolerances

Rhithrogena sp.

Taxa # 35

Temp Preference 11.97

Tolerance 1.86

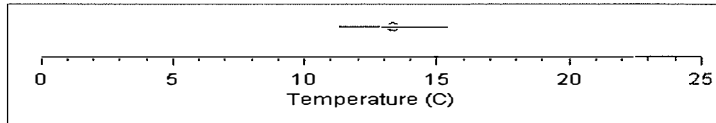


Serratella tibialis

Taxa # 54

Temp Preference 13.34

Tolerance 2.08

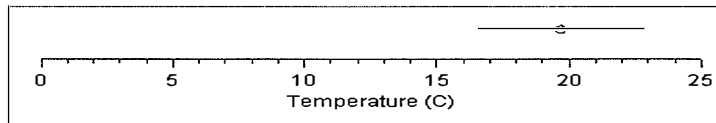


Tricorythodes minutus

Taxa # 58

Temp Preference 19.69

Tolerance 3.17

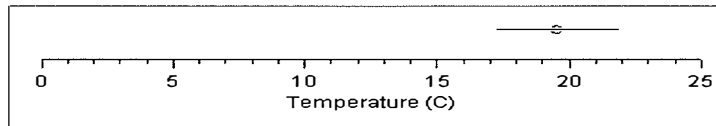


Tricorythodes sp.

Taxa # 57

Temp Preference 19.52

Tolerance 2.32



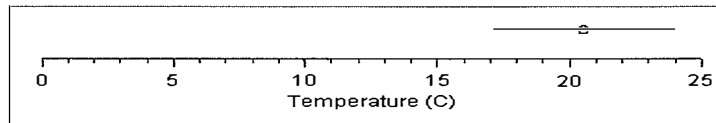
Hemiptera

Corixidae

Taxa # 136

Temp Preference 20.52

Tolerance 3.42



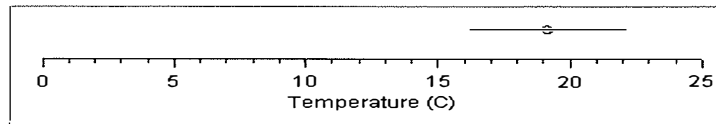
Odonata

Argia sp.

Taxa # 8

Temp Preference 19.14

Tolerance 2.95



Macroinvertebrate Temperature Preferences and Tolerances

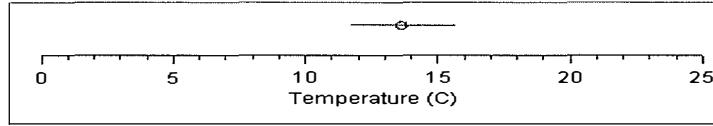
Plecoptera

Amphinemura sp.

Taxa # 82

Temp Preference 13.63

Tolerance 1.98

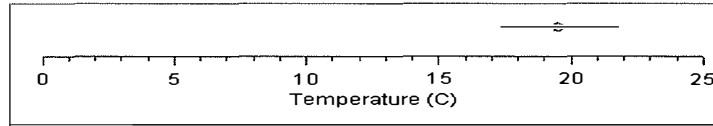


Calineuria californica

Taxa # 109

Temp Preference 19.53

Tolerance 2.24

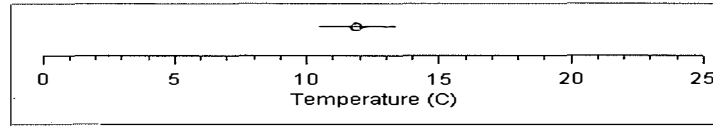


Capniidae

Taxa # 100

Temp Preference 11.88

Tolerance 1.5

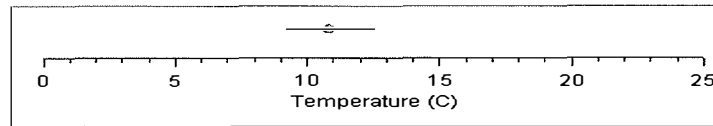


Chloroperlidae

Taxa # 130

Temp Preference 10.82

Tolerance 1.67

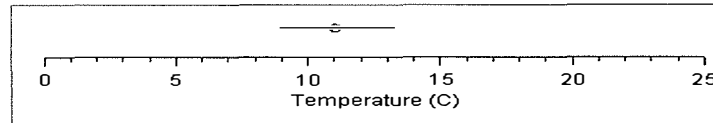


Cultus sp.

Taxa # 116

Temp Preference 11.04

Tolerance 2.19

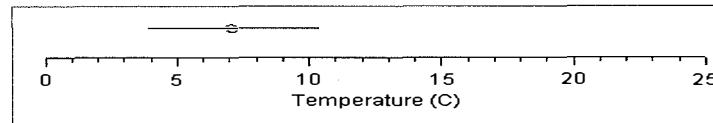


Despaxia augusta

Taxa # 94

Temp Preference 7.09

Tolerance 3.24

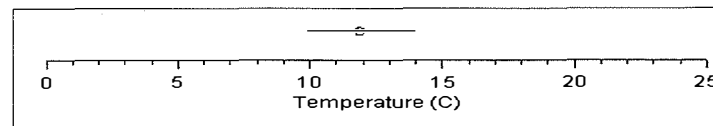


Doroneuria sp.

Taxa # 110

Temp Preference 11.88

Tolerance 2.02

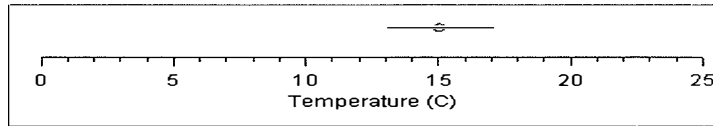


Macroinvertebrate Temperature Preferences and Tolerances

Hesperoperla pacifica

Taxa # 113

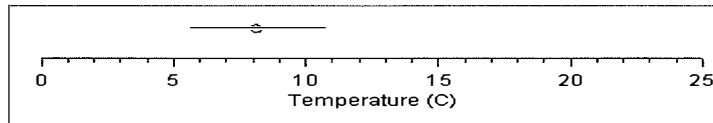
Temp Preference 15.03
Tolerance 2.04



Kogotus sp.

Taxa # 119

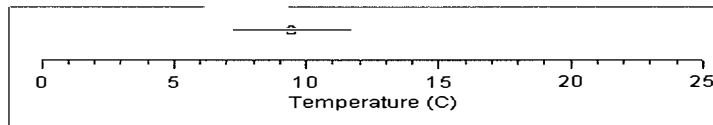
Temp Preference 8.12
Tolerance 2.54



Leuctridae

Taxa # 93

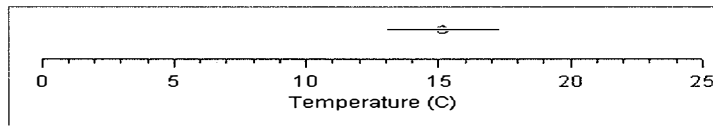
Temp Preference 9.43
Tolerance 2.24



Malenka sp.

Taxa # 83

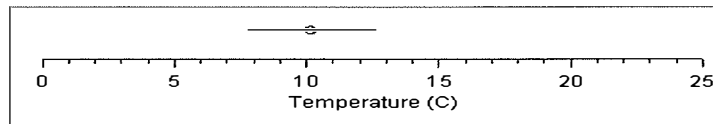
Temp Preference 15.13
Tolerance 2.13



Megarcys sp.

Taxa # 121

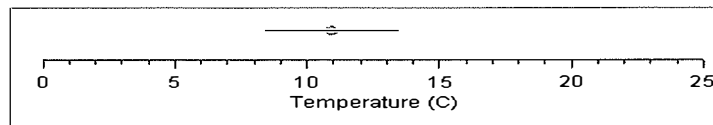
Temp Preference 10.15
Tolerance 2.42



Neaviperla sp.

Taxa # 590

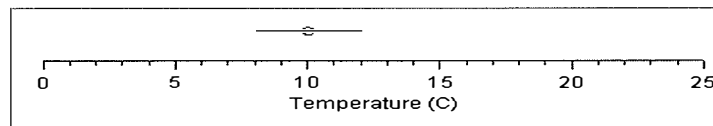
Temp Preference 10.93
Tolerance 2.53



Nemouridae

Taxa # 81

Temp Preference 10.03
Tolerance 1.98



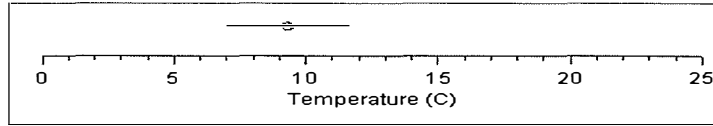
Macroinvertebrate Temperature Preferences and Tolerances

Paraperla sp.

Taxa # 133

Temp Preference 9.32

Tolerance 2.32

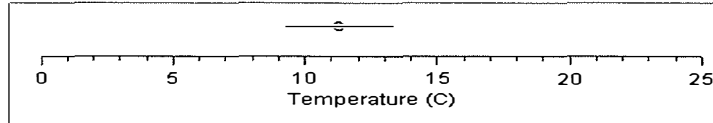


Perlidae

Taxa # 104

Temp Preference 11.26

Tolerance 2.07

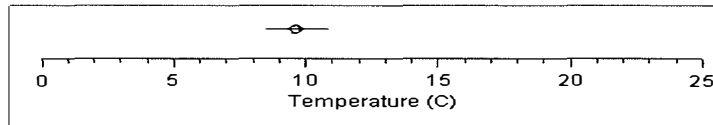


Perlodidae

Taxa # 114

Temp Preference 9.64

Tolerance 1.19

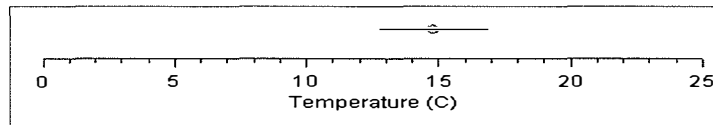


Pteronarcella sp.

Taxa # 66

Temp Preference 14.

Tolerance 2.

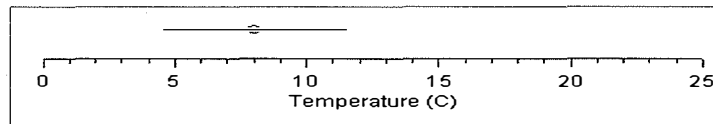


Setvena sp.

Taxa # 787

Temp Preference 7.

Tolerance 3.

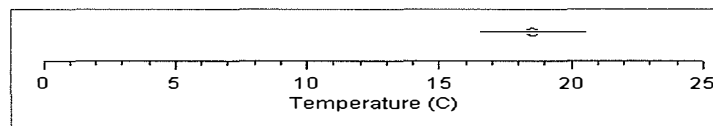


Skwala sp.

Taxa # 126

Temp Preference 18.

Tolerance 1.

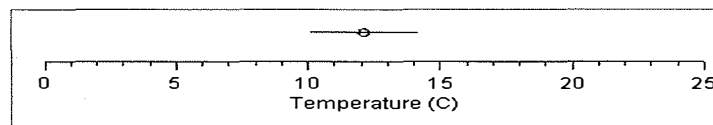


Suwallia sp.

Taxa # 577

Temp Preference 12.

Tolerance 2.



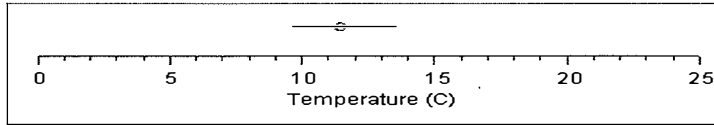
Macroinvertebrate Temperature Preferences and Tolerances

Sweltsa sp.

Taxa # 134

Temp Preference 11.45

Tolerance 1.97

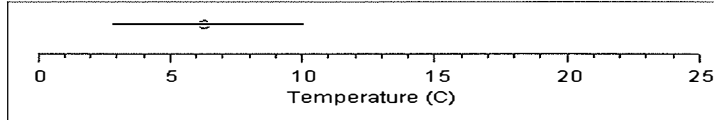


Taeniopterygidae

Taxa # 77

Temp Preference 6.3

Tolerance 3.64

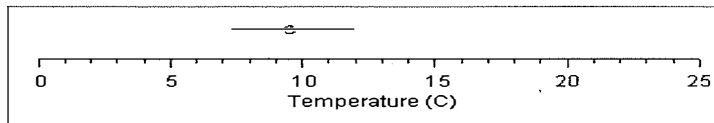


Visoka cataractae

Taxa # 87

Temp Preference 9.52

Tolerance 2.32

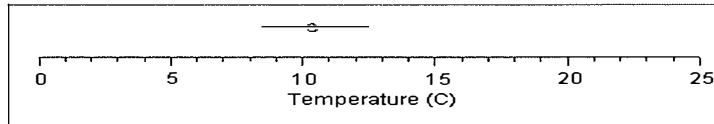


Yoraperla brevis

Taxa # 75

Temp Preference 10.36

Tolerance 2.04

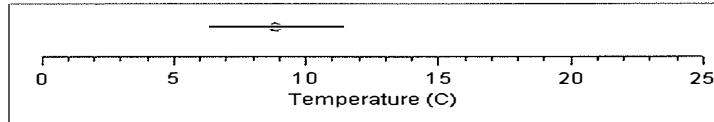


Yoraperla sp.

Taxa # 74

Temp Preference 8.84

Tolerance 2.59

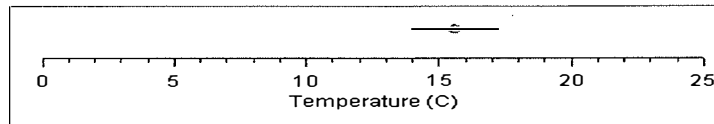


Zapada cinctipes

Taxa # 89

Temp Preference 15.58

Tolerance 1.63

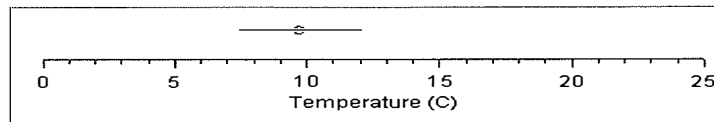


Zapada columbiana

Taxa # 90

Temp Preference 9.71

Tolerance 2.29



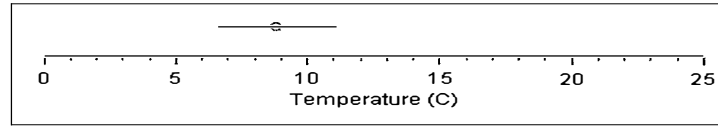
Macroinvertebrate Temperature Preferences and Tolerances

Zapada oregonensis gr.

Taxa # 92

Temp Preference 8.8

Tolerance 2.27

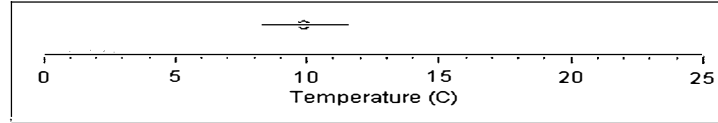


Zapada sp.

Taxa # 88

Temp Preference 9.88

Tolerance 1.67



Macroinvertebrate Temperature Preferences and Tolerances

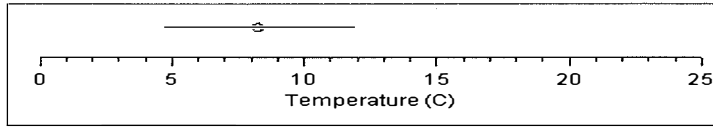
Trichoptera

Anagapetus sp.

Taxa # 172

Temp Preference 8.26

Tolerance 3.63

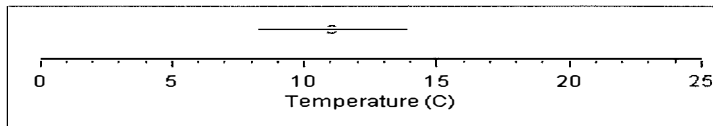


Apatania sp.

Taxa # 212

Temp Preference 11.04

Tolerance 2.81

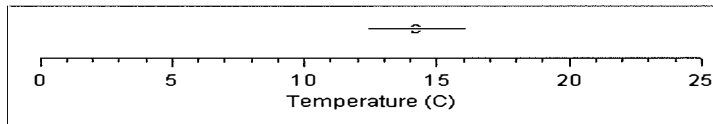


Arctopsyche grandis

Taxa # 192

Temp Preference 14.2

Tolerance 1.81

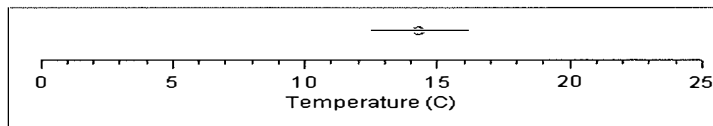


Brachycentrus americanus

Taxa # 234

Temp Preference 14.29

Tolerance 1.86

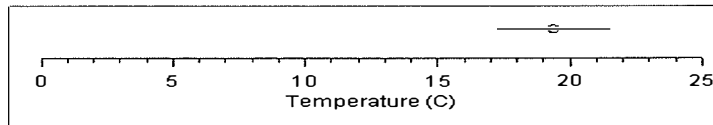


Brachycentrus occidentalis

Taxa # 235

Temp Preference 19.37

Tolerance 2.14

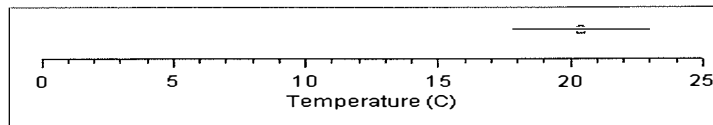


Cheumatopsyche sp.

Taxa # 197

Temp Preference 20.38

Tolerance 2.57

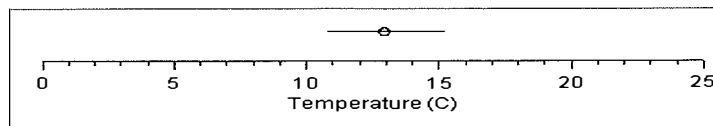


Dolophilodes sp.

Taxa # 188

Temp Preference 12.94

Tolerance 2.21



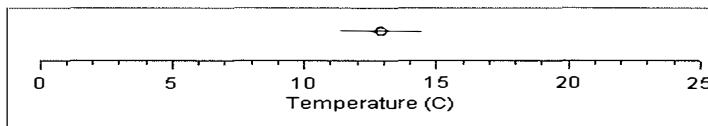
Macroinvertebrate Temperature Preferences and Tolerances

Glossosoma sp.

Taxa # 173

Temp Preference 12.88

Tolerance 1.52

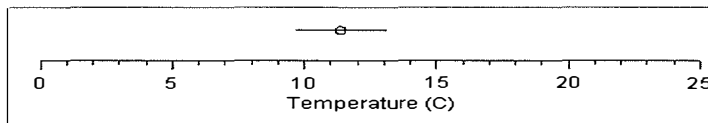


Glossosomatidae

Taxa # 170

Temp Preference 11.37

Tolerance 1.74

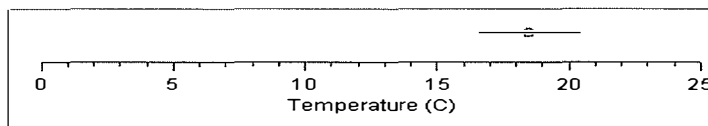


Hydropsyche sp.

Taxa # 198

Temp Preference 18.49

Tolerance 1.92

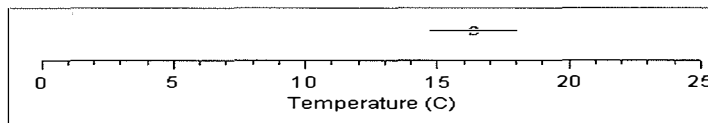


Hydropsychidae

Taxa # 196

Temp Preference 16.38

Tolerance 1.65

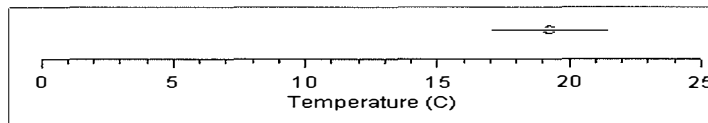


Hydroptila sp.

Taxa # 182

Temp Preference 19.23

Tolerance 2.23

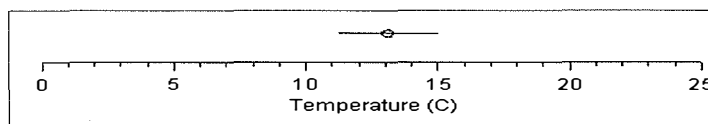


Limnephilidae

Taxa # 199

Temp Preference 13.09

Tolerance 1.89

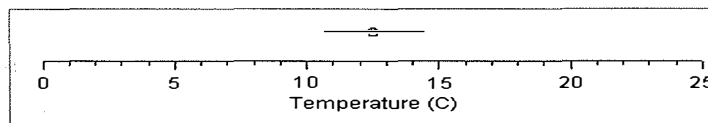


Micrasema sp.

Taxa # 236

Temp Preference 12.52

Tolerance 1.92



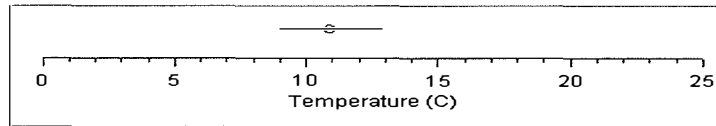
Macroinvertebrate Temperature Preferences and Tolerances

Neophylax sp.

Taxa # 225

Temp Preference 10.88

Tolerance 1.96

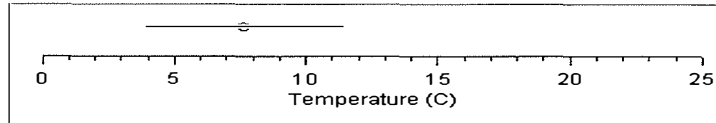


Neothremma alicia

Taxa # 230

Temp Preference 7.65

Tolerance 3.75

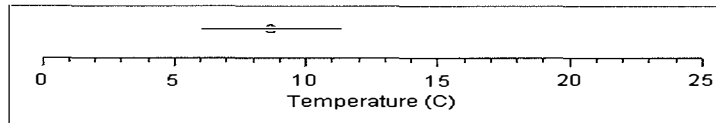


Neothremma sp.

Taxa # 229

Temp Preference 8.66

Tolerance 2.64

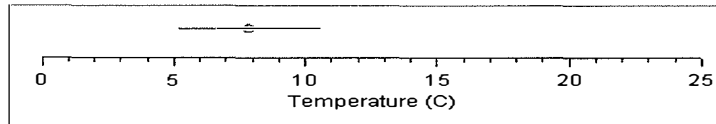


Oligophlebodes sp.

Taxa # 231

Temp Preference 7.87

Tolerance 2.7

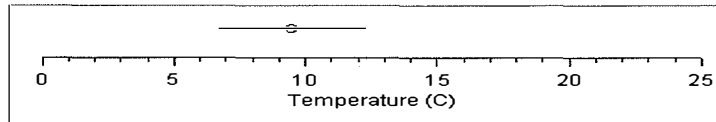


Parapsyche elsis

Taxa # 195

Temp Preference 9.47

Tolerance 2.76

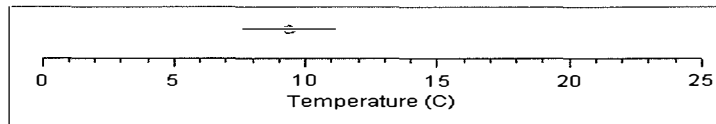


Parapsyche sp.

Taxa # 193

Temp Preference 9.38

Tolerance 1.74

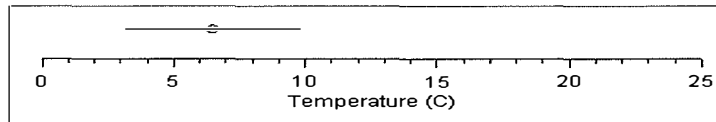


Rhyacophila alberta gr.

Taxa # 155

Temp Preference 6.47

Tolerance 3.34

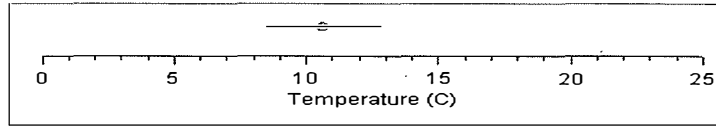


Macroinvertebrate Temperature Preferences and Tolerances

Rhyacophila betteni gr.

Taxa # 157

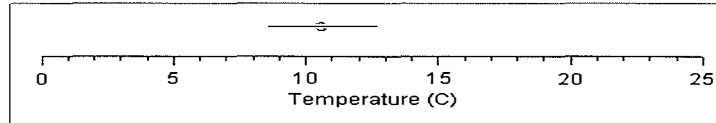
Temp Preference 10.61
Tolerance 2.16



Rhyacophila brunnea gr.

Taxa # 158

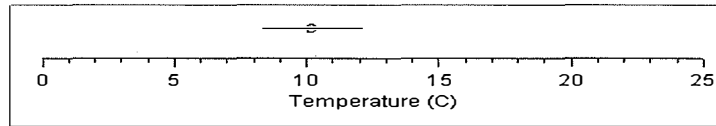
Temp Preference 10.56
Tolerance 2.06



Rhyacophila hyalinata gr.

Taxa # 160

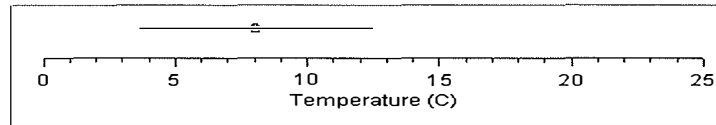
Temp Preference 10.2
Tolerance 1.92



Rhyacophila iranda gr.

Taxa # 161

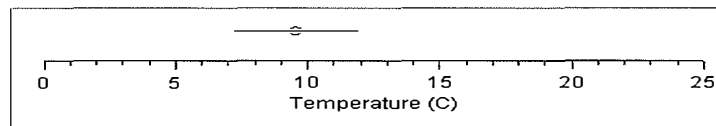
Temp Preference 8.02
Tolerance 4.39



Rhyacophila narvae

Taxa # 166

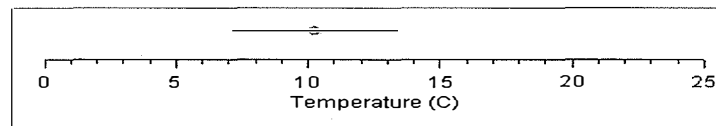
Temp Preference 9.53
Tolerance 2.34



Rhyacophila pellisa

Taxa # 167

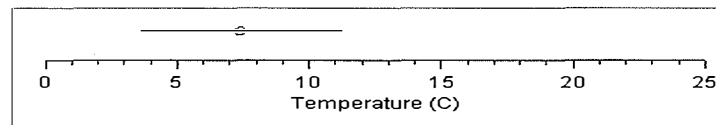
Temp Preference 10.22
Tolerance 3.14



Rhyacophila sibirica gr.

Taxa # 164

Temp Preference 7.42
Tolerance 3.82



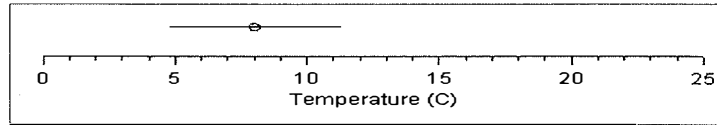
Macroinvertebrate Temperature Preferences and Tolerances

Rhyacophila vaccua Milne

Taxa # 613

Temp Preference 8.02

Tolerance 3.27

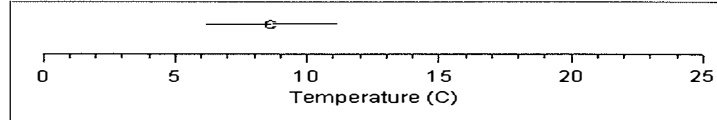


Rhyacophila vagrita gr.

Taxa # 168

Temp Preference 8.63

Tolerance 2.52

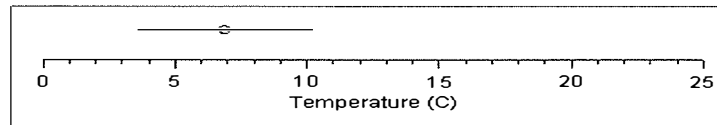


Rhyacophila valuma

Taxa # 713

Temp Preference 6.87

Tolerance 3.3

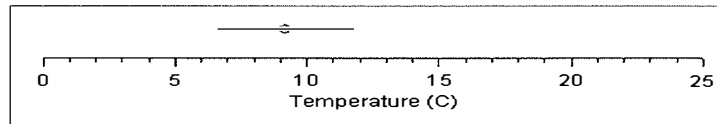


Rhyacophila valuma/pellisa

Taxa # 801

Temp Preference 9.16

Tolerance 2.59

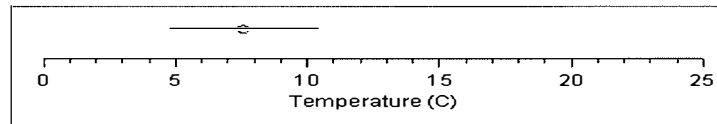


Rhyacophila verrula

Taxa # 169

Temp Preference 7.58

Tolerance 2.83

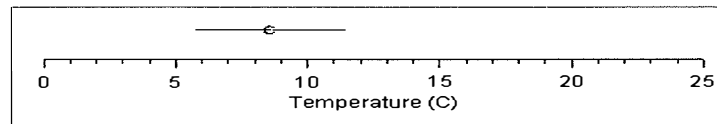


Rhyacophila vofixa gr.

Taxa # 812

Temp Preference 8.57

Tolerance 2.84



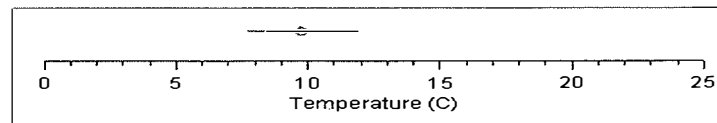
Tricladida

Polycelis coronata

Taxa # 619

Temp Preference 9.76

Tolerance 2.1



Appendix B.

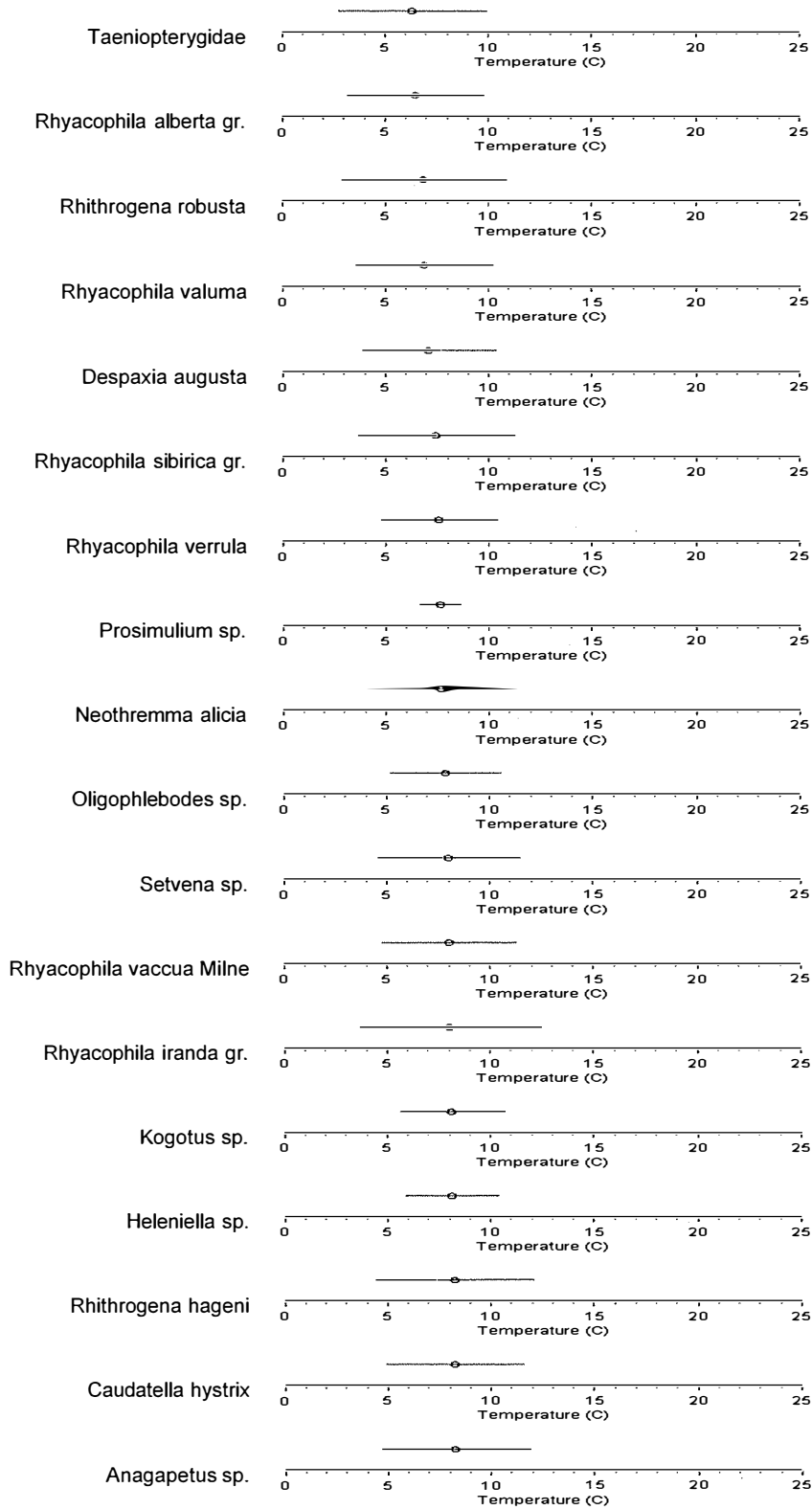
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Rhyacophila sibirica gr.....	B.1
Rhyacophila verrula.....	B.1
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Neothremma alicia.....	B.1
Oligophlebodes sp.	B.1
Setvena sp.	B.1
Rhyacophila vaccua Milne.....	B.1
Rhyacophila iranda gr.....	B.1
Kogotus sp.	B.1
Heleniella sp.	B.1
Rhithrogena hageni.....	B.1
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Ameletus similor.....	B.2
Baetis bicaudatus	B.2
Zapada oregonensis gr.....	B.2
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Rhyacophila valuma/pellisa	B.2
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Drunella flavilinea/coloradensis	B.3
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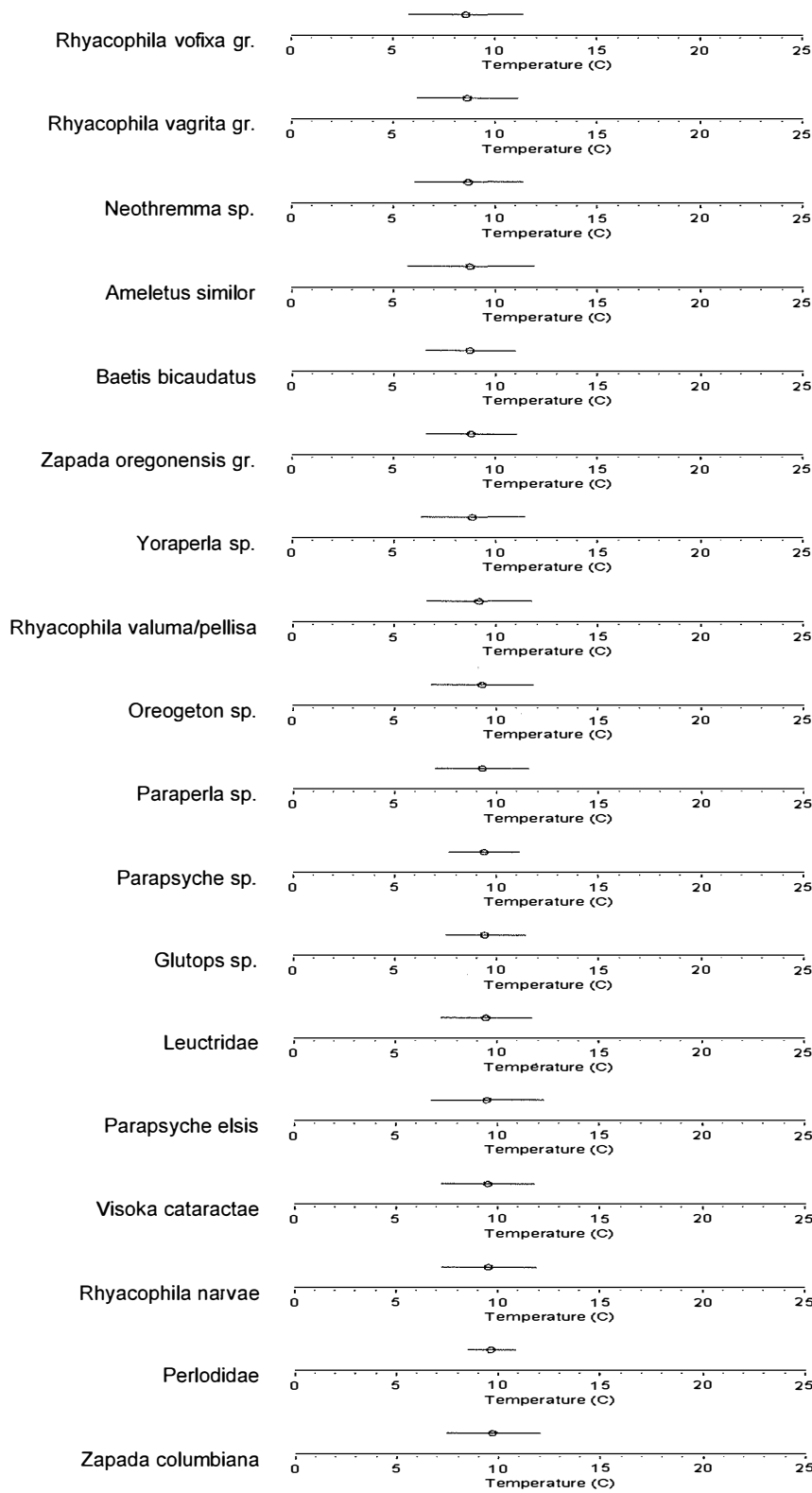
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Megarcys sp.....	B.3
Rhyacophila hyalinata gr.....	B.3
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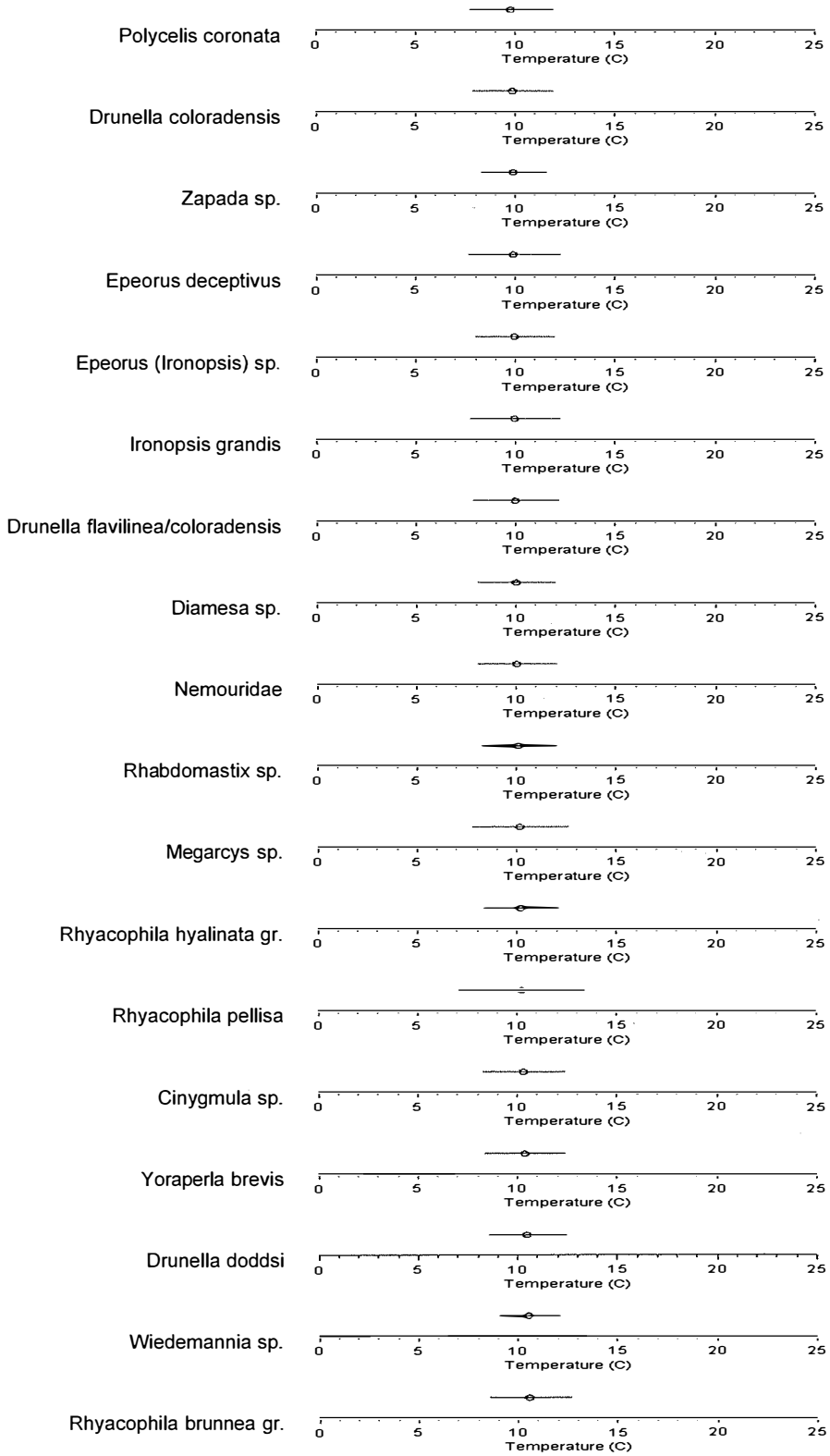
Macroinvertebrate Temperature Preferences in Ascending Order



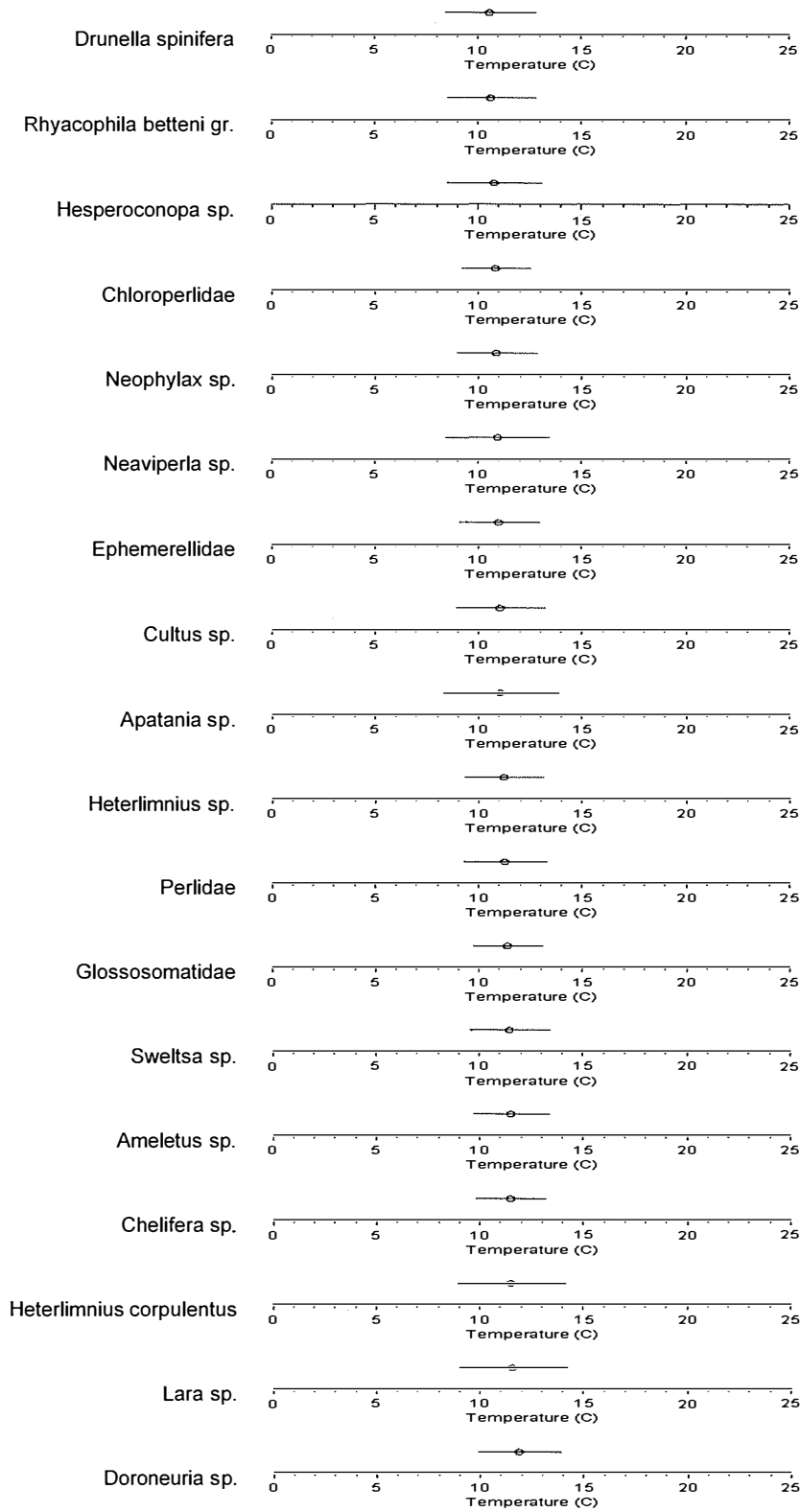
Macroinvertebrate Temperature Preferences in Ascending Order



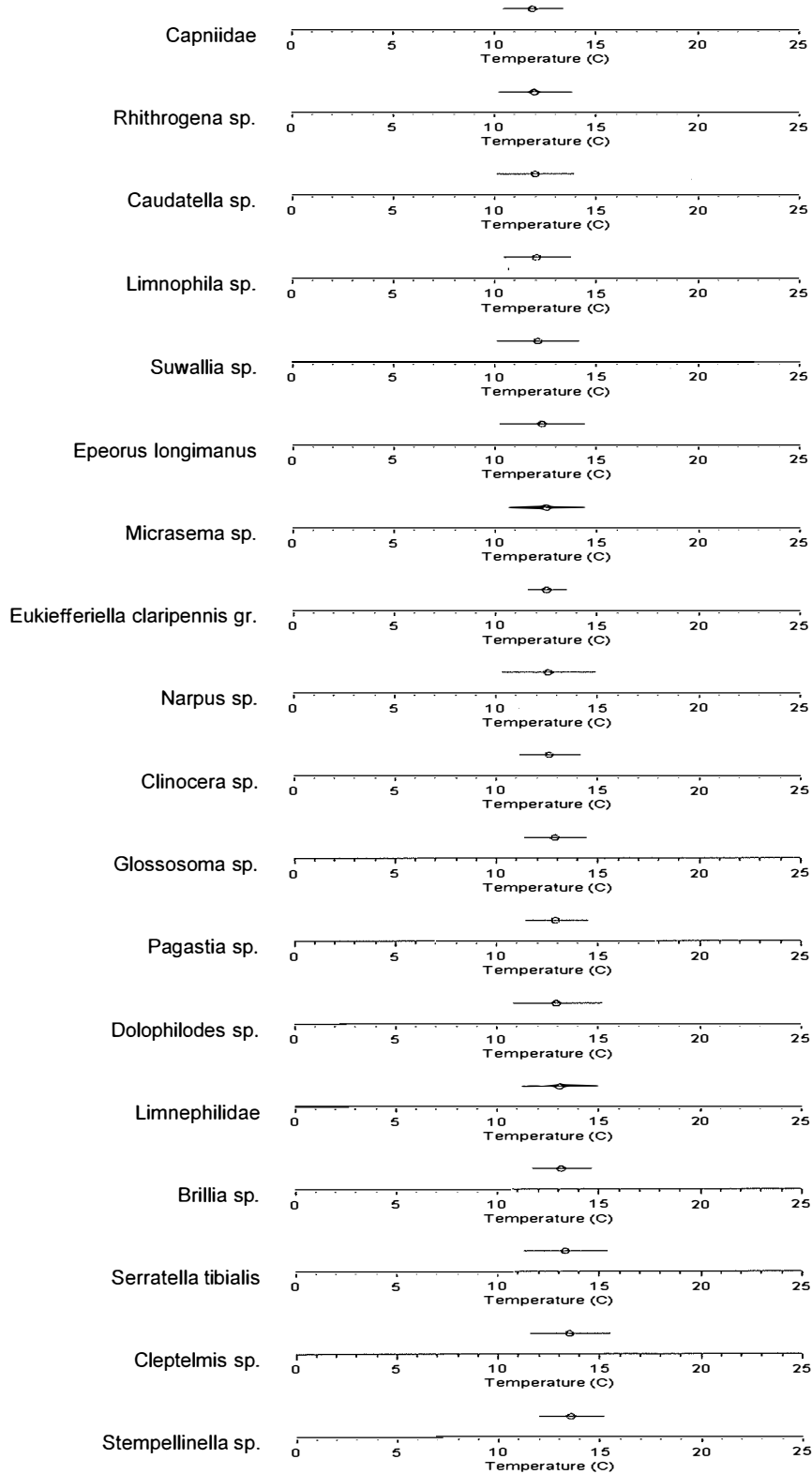
Macroinvertebrate Temperature Preferences in Ascending Order



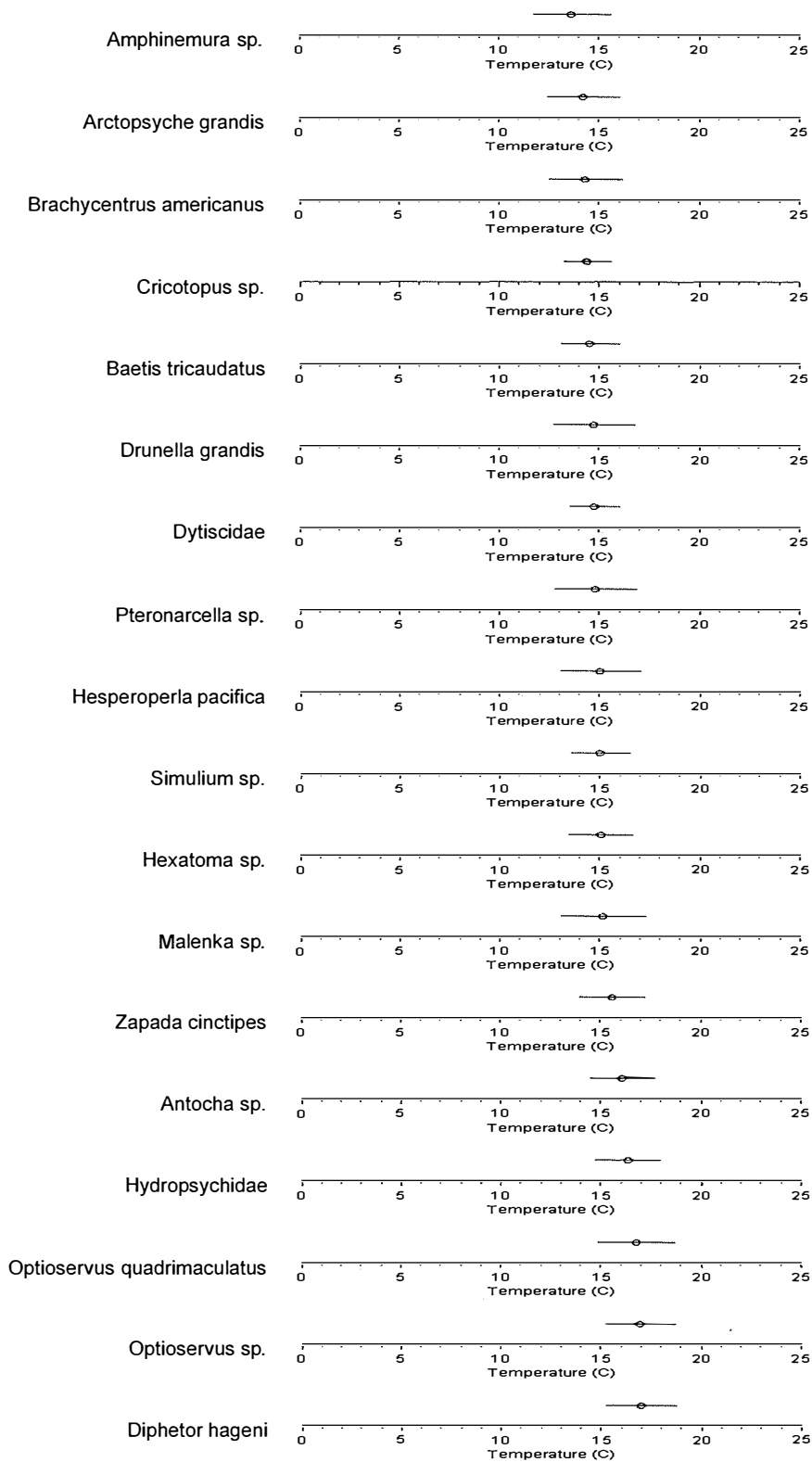
Macroinvertebrate Temperature Preferences in Ascending Order



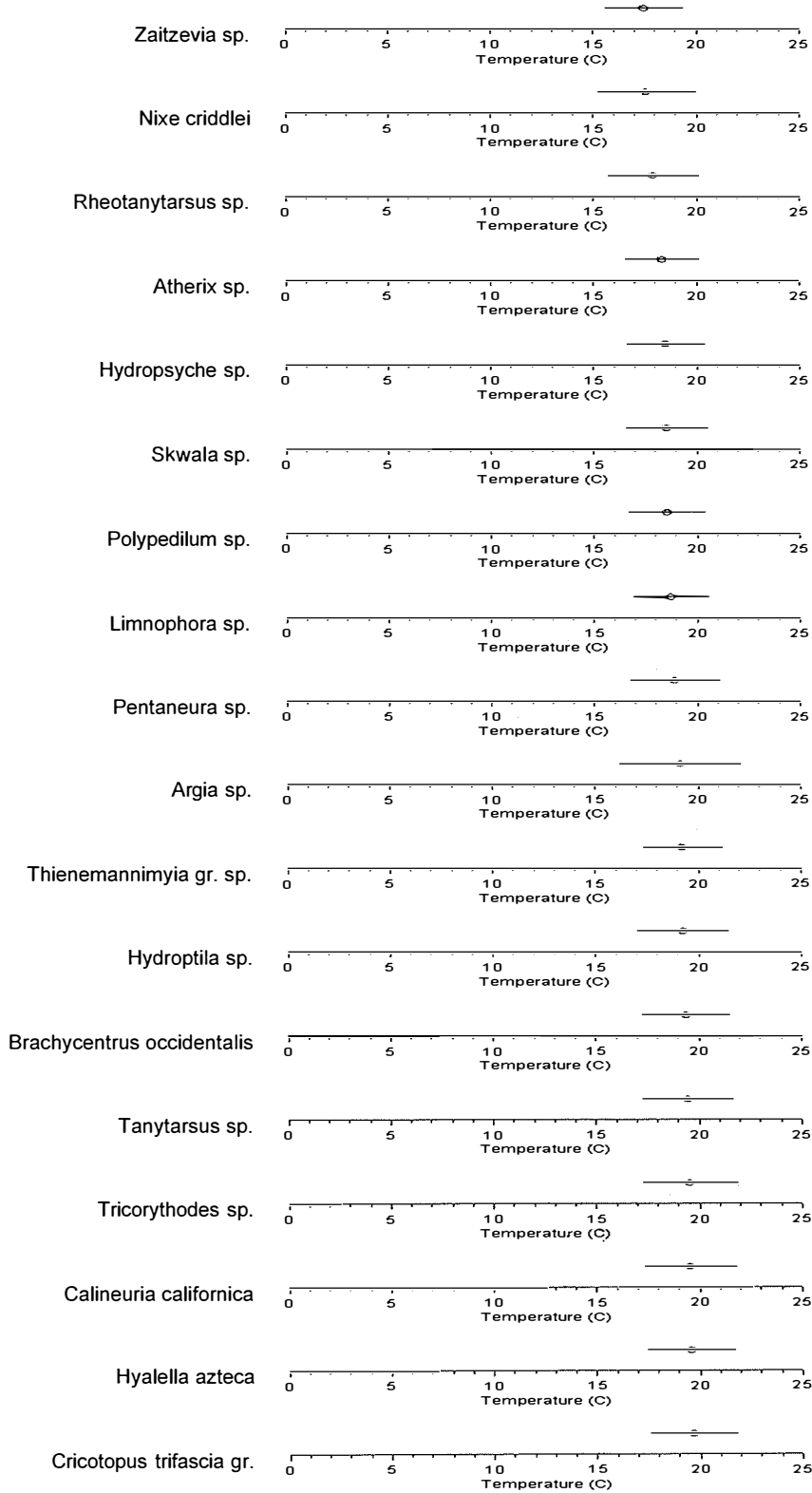
Macroinvertebrate Temperature Preferences in Ascending Order



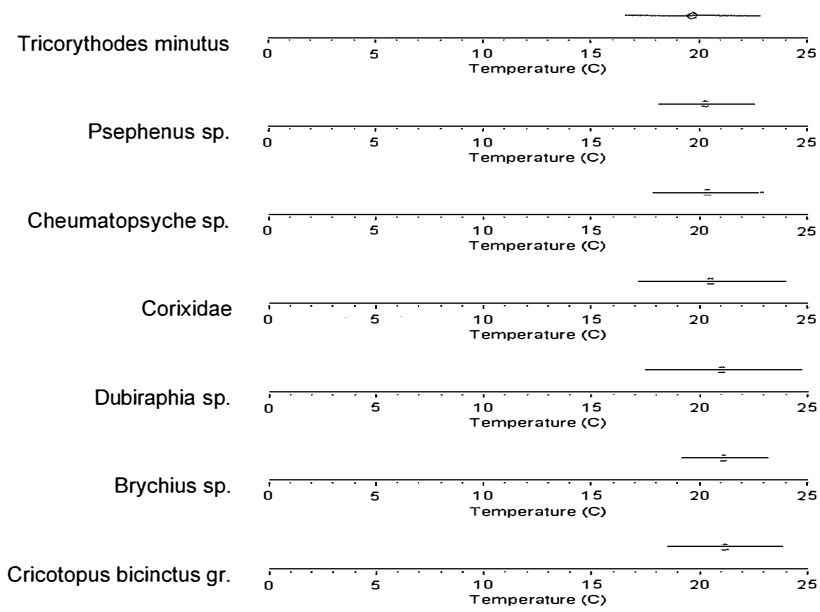
Macroinvertebrate Temperature Preferences in Ascending Order



Macroinvertebrate Temperature Preferences in Ascending Order



Macroinvertebrate Temperature Preferences in Ascending Order



Appendix C.

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Neothremma sp.....	C.5
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Baetis bicaudatus.....	C.6
Zapada oregonensis gr.....	C.6
Yoraperla sp.....	C.6
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Visoka cataractae.....	C.8
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Apatania sp.....	C.11
Heterlimnius corpulentus.....	C.11
Lara sp.....	C.11

Obligate Cold Macroinvertebrate Taxa

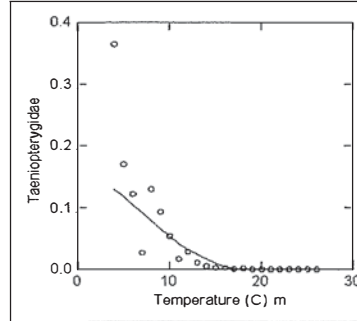
Taeniopterygidae

Plecoptera

Taxa # 77

Temp Preference 6.3

Tolerance: 3.64



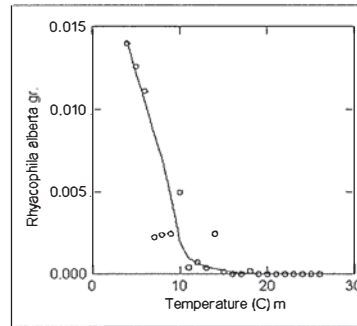
Rhyacophila alberta gr.

Trichoptera

Taxa # 155

Temp Preference 6.47

Tolerance: 3.34



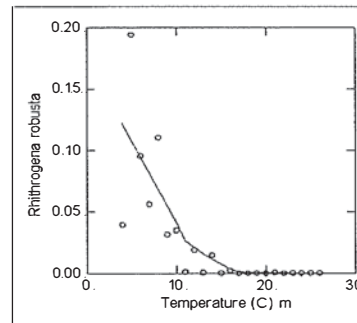
Rhithrogena robusta

Ephemeroptera

Taxa # 625

Temp Preference 6.84

Tolerance: 4



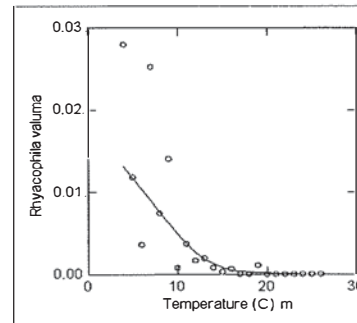
Rhyacophila valuma

Trichoptera

Taxa # 713

Temp Preference 6.87

Tolerance: 3.3



Obligate Cold Macroinvertebrate Taxa

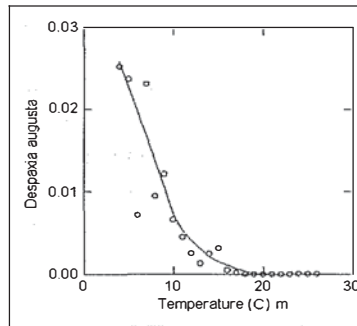
Despaxia augusta

Plecoptera

Taxa # 94

Temp Preference 7.09

Tolerance: 3.24



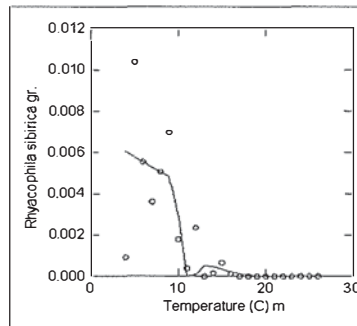
Rhyacophila sibirica gr.

Trichoptera

Taxa # 164

Temp Preference 7.42

Tolerance: 3.82



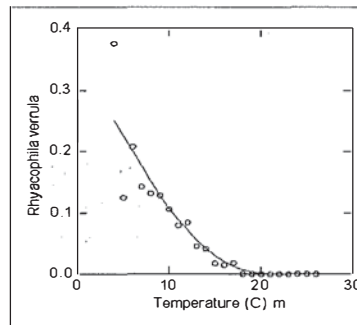
Rhyacophila verrula

Trichoptera

Taxa # 169

Temp Preference 7.58

Tolerance: 2.83



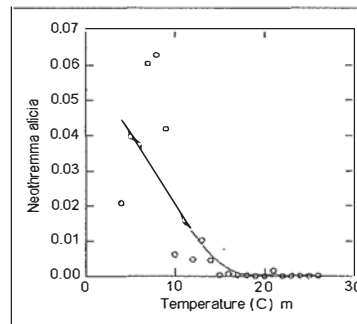
Neothremma alicia

Trichoptera

Taxa # 230

Temp Preference 7.65

Tolerance: 3.75



Obligate Cold Macroinvertebrate Taxa

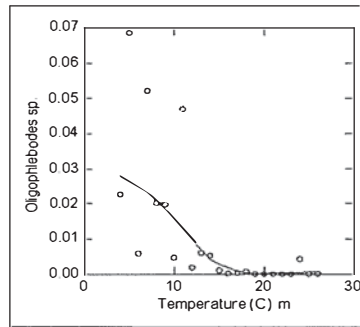
Oligophlebodes sp.

Trichoptera

Taxa # 231

Temp Preference 7.87

Tolerance: 2.7



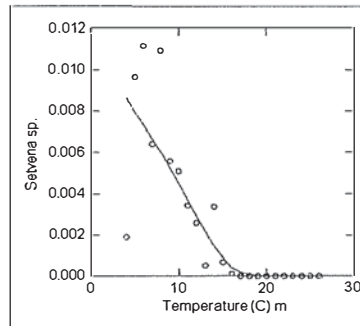
Setvena sp.

Plecoptera

Taxa # 787

Temp Preference 7.99

Tolerance: 3.46



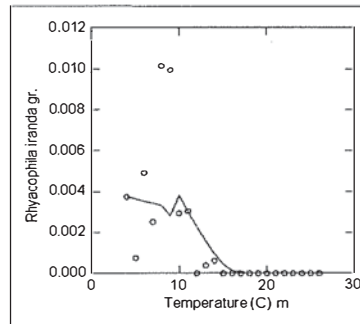
Rhyacophila iranda gr.

Trichoptera

Taxa # 161

Temp Preference 8.02

Tolerance: 4.39



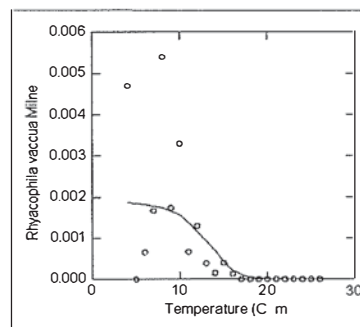
Rhyacophila vaccua Milne

Trichoptera

Taxa # 613

Temp Preference 8.02

Tolerance: 3.27



Obligate Cold Macroinvertebrate Taxa

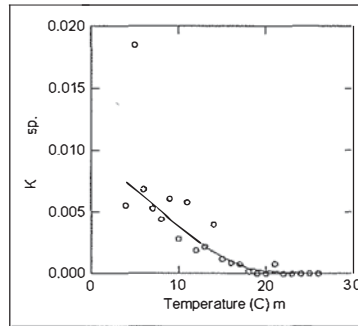
Kogotus sp.

Pecopectera

Taxa # 119

Temp Preference 8.12

Tolerance: 2.54



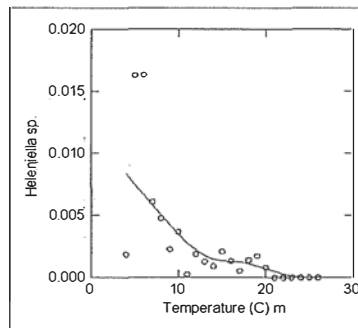
Heleniella sp.

Chironomidae (family)

Taxa # 352

Temp Preference 8.13

Tolerance: 2.29



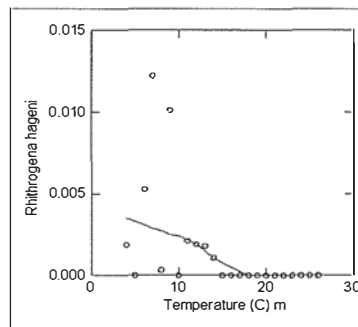
Rhithrogena hageni

Ephemeroptera

Taxa # 485

Temp Preference 8.25

Tolerance: 3.86



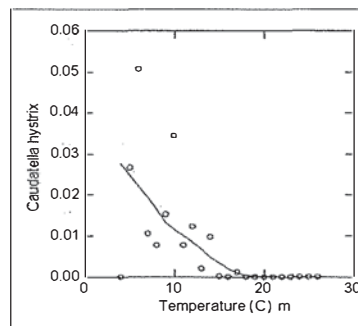
Caudatella hystrix

Ephemeroptera

Taxa # 42

Temp Preference 8.25

Tolerance: 3.34



Obligate Cold Macroinvertebrate Taxa

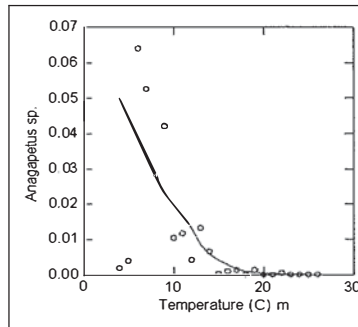
Anagapetus sp.

Trichoptera

Taxa # 172

Temp Preference 8.26

Tolerance: 3.63



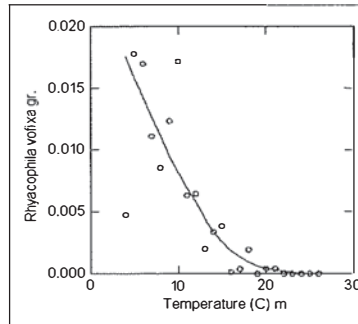
Rhyacophila vofixa gr.

Trichoptera

Taxa # 812

Temp Preference 8.57

Tolerance: 2.84



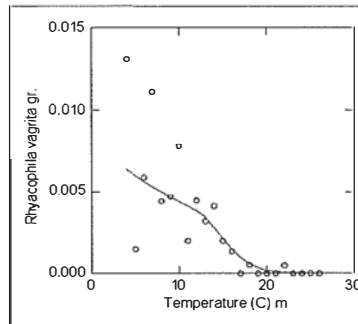
Rhyacophila vagrita gr.

Trichoptera

Taxa # 168

Temp Preference 8.63

Tolerance: 2.52



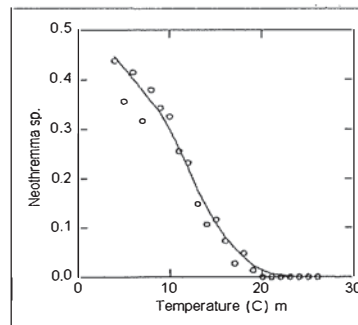
Neothremma sp.

Trichoptera

Taxa # 229

Temp Preference 8.66

Tolerance: 2.64



Obligate Cold Macroinvertebrate Taxa

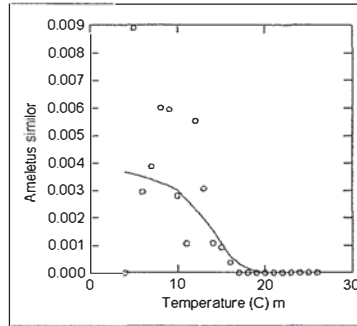
Ameletus similis

Ephemeroptera

Taxa # 693

Temp Preference 8.74

Tolerance: 3.12



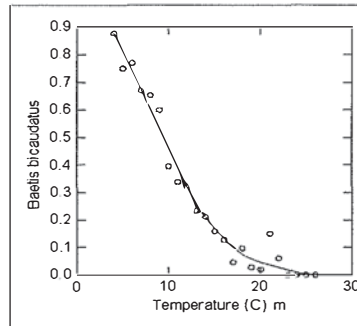
Baetis bicaudatus

Ephemeroptera

Taxa # 18

Temp Preference 8.76

Tolerance: 2.22



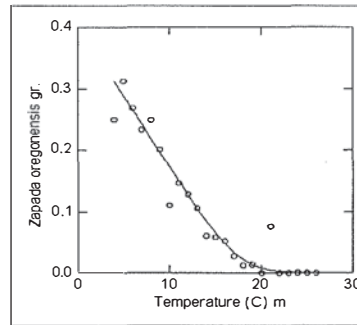
Zapada oregonensis gr.

Plecoptera

Taxa # 92

Temp Preference 8.8

Tolerance: 2.27



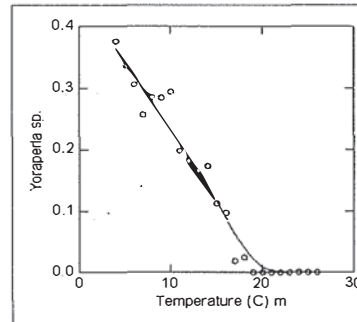
Yoraperla sp.

Plecoptera

Taxa # 74

Temp Preference 8.84

Tolerance: 2.59



Obligate Cold Macroinvertebrate Taxa

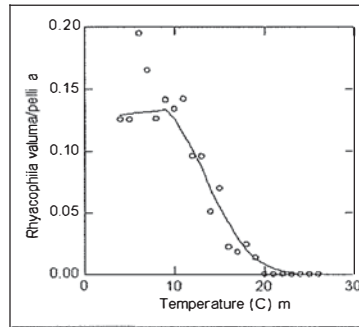
Rhyacophila valuma/pellisa

Trichoptera

Taxa # 801

Temp Preference 9.16

Tolerance: 2.59



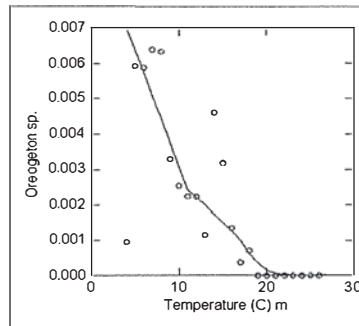
Oreogeton sp.

Diptera

580

Temp Preference 9.29

Tolerance: 2.56



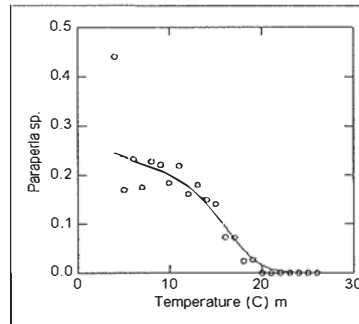
Paraperla sp.

Plecoptera

Taxa # 133

Temp Preference 9.32

Tolerance: 2.32



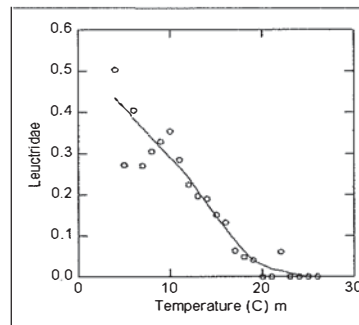
Leuctridae

Plecoptera

Taxa # 93

Temp Preference 9.43

Tolerance: 2.24



Obligate Cold Macroinvertebrate Taxa

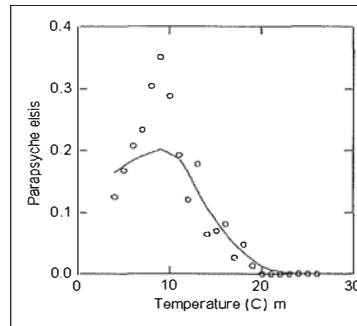
Parapsyche elsis

Trichoptera

Taxa # 195

Temp Preference 9.47

Tolerance: 2.76



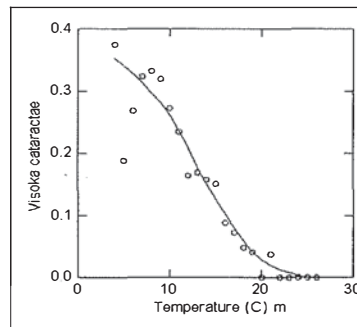
Visoka cataractae

Plecoptera

Taxa # 87

Temp Preference 9.52

Tolerance: 2.32



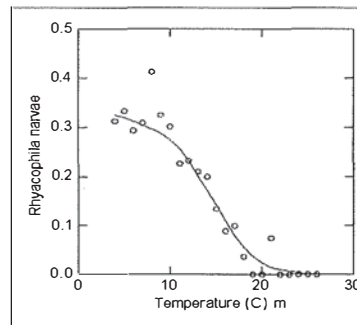
Rhyacophila narvae

Trichoptera

Taxa # 166

Temp Preference 9.53

Tolerance: 2.34



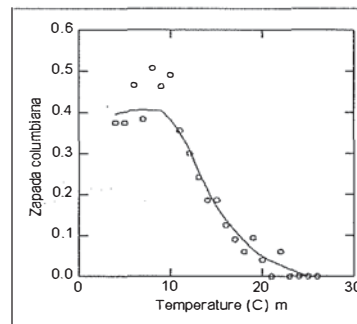
Zapada columbiana

Plecoptera

Taxa # 90

Temp Preference 9.71

Tolerance: 2.29



Obligate Cold Macroinvertebrate Taxa

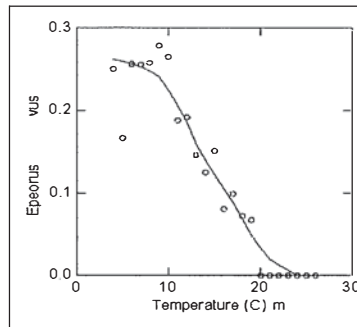
Epeorus *deceptivus*

Ephemeroptera

Taxa # 29

Temp Preference 9.9

Tolerance: 2.31



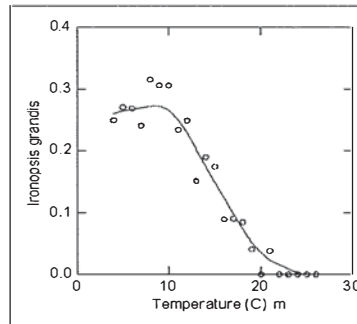
Ironopsis *grandis*

Ephemeroptera

Taxa # 32

Temp Preference 9.95

Tolerance: 2.3



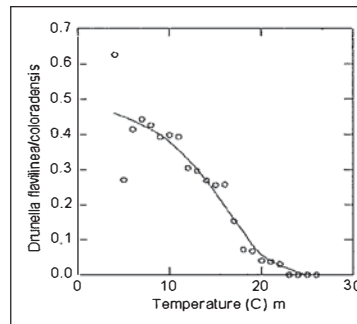
Drunella *flavilinea/coloradensis*

Ephemeroptera

Taxa # 622

Temp Preference 9.98

Tolerance: 2.17



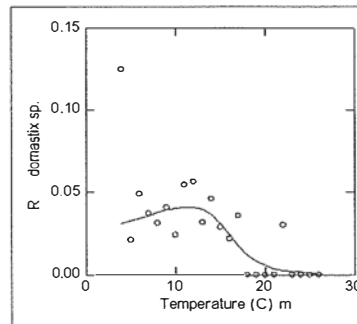
Rhabdomastix sp.

Diptera

Taxa # 615

Temp Preference 10.12

Tolerance: 1.9



Obligate Cold Macroinvertebrate Taxa

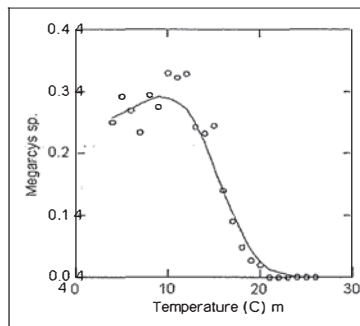
Megarcys sp.

Plecoptera

Taxa # 121

Temp Preference 10.15

Tolerance: 2.42



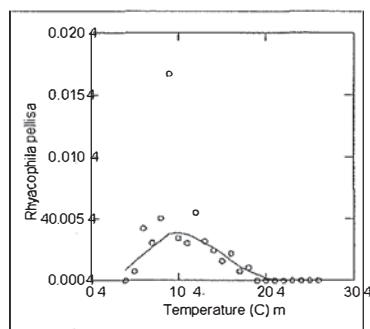
Rhyacophila pellisa

Trichoptera

Taxa # 167

Temp Preference 10.22

Tolerance: 3.14



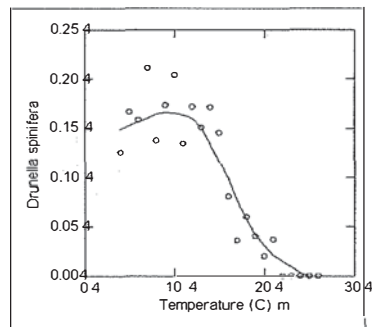
Drunella spinifera

Ephemeroptera

Taxa # 48

Temp Preference 10.56

Tolerance: 2.21



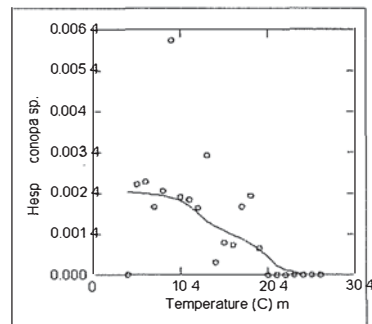
Hesperoconopa sp.

Diptera

Taxa # 287

Temp Preference 10.76

Tolerance: 2.34



Obligate Cold Macroinvertebrate Taxa

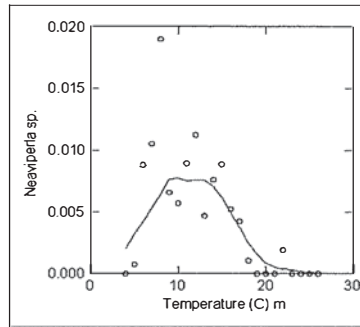
Neaviperla sp.

Plecoptera

Taxa # 590

Temp Preference 10.93

Tolerance: 2.53



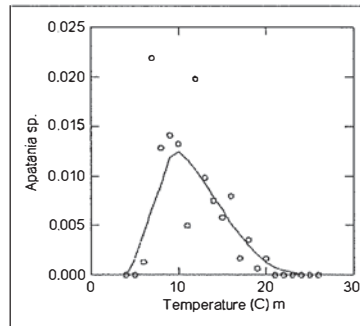
Apatania sp.

Trichoptera

Taxa # 212

Temp Preference 11.04

Tolerance: 2.81



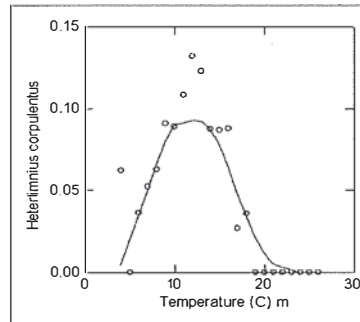
Heterlimnius corpulentus

Coleoptera

Taxa # 263

Temp Preference 11.51

Tolerance: 2.66



Lara sp.

Coleoptera

Taxa # 596

Temp Preference 11.56

Tolerance: 2.64

