BIOLOGICAL INDICATORS OF WATER QUALITY IN RIVER GANGA

CENTRAL POLLUTION CONTROL BOARD
MINISTRY OF ENVIRONMENT, FOREST & CLIMATE CHANGE

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FOREWORD

One of the long term objective for pollution control authorities, is to ensure that all the natural surface water bodies should remain free from harmful effects, caused by pollution discharges, to man and aquatic life in aquatic environment. Bio-monitoring of water quality can play a vital role in planning effective pollution control strategy, in order to restore the biological health of a river. Biological assessment relies on the fact that pollution of water bodies will cause change in physical and chemical environment of the water and that these changes will disrupt the ecological balance of the system. Thus, by measuring the extent of ecological upset, the severity of pollution can be estimated. Use of benthic macro-invertebrates for bio-monitoring is a cost-effective tool to determine cumulative impact of pollution in water quality of River Ganga. Biological indicators have been identified for assessing different levels of pollution in water quality of River Ganga through two phase bio-monitoring during 2014, 2015 and 2016 in the states of Uttarakhand, Uttar Pradesh, Bihar, Jharkhand and West Bengal. A total of 20 indicators were identified in Clean water (Class 'A'), 116 indicators were identified in Slight pollution (Class 'B'), 161 indicators were identified in Moderate pollution (Class 'C') and 50 indicators were identified in Heavy pollution (Class 'D') biological water quality in river stretches of River Ganga and tributaries. None of the river stretch indicated Severe pollution (Class 'E') in River Ganga and its tributaries. Presence of these benthic fauna in water quality of River Ganga with respect to water quality classes, have been indicated by colour codes of Blue, Light Blue, Green, Orange and Red respectively. These indicators can be identified through reference book of'Benthic macro-invertebrates of River Ganga' (2017) and "Biological Health of River Ganga (2017)

BIOLOGICAL WATER QUALITY CRITERIA

For assessment of the actual health of water bodies, CPCB has derived a Biological Water Quality Criteria (BWQC) for water quality evaluation. This system is based on the range of saprobic and diversity score of the benthic macro-invertebrate families with respect to water quality. The system has been developed after extensive field trials and calibration on the saprobic and diversity information of different taxonomic groups of benthic animals collected from artificial substratum and natural substratum of various water bodies. To indicate changes in water quality to different grades of pollution level, the entire taxonomic groups, with their range of saprobic score from 1 to 10, in combination with the range of diversity score from 0 to 1 has been classified into five different classes of water quality. The abnormal combination of saprobic score and diversity score indicates sudden change in environmental conditions. The biological water quality is evaluated using benthic fauna by combining the observed saprobic score and diversity score within a given range and the biological water quality class is determined.

BIOLOGICAL WATER QUALITY WITH RESPECT TO RANGE OF DIVERSITY AND SAPROBIC SCORE

Range of Saprobic Score(0-10)	Range of Diversity Score (0 -1)	Water Quality	Biological Water Quality Class	Indicator colour
7 and more	0.2-1.0	Clean	A	Blue
6-7	0.5-1.0	Slight Pollution	B	Light Blue
3-6	0.3-0.9	Moderate Pollution	C	Green
2-5	0.4-less	Heavy Pollution	D	Orange
0-2	0-0.2	Severe Pollution	E	Red

CLEAN WATER QUALITY LOCATIONS INDICATING CLASS 'A' IN RIVER GANGA

Location code	Name of Location	Duration	State
UK5	Barrage at Rishikesh	25-Jun-14	Uttarakhand
UK7	Dham Kothi on Ganga Nahar, downstream Har- ki – Paori, Haridwar	21-Jun-14	Uttarakhand
UK 8a	Upstream of STP outlet at Jagjeetpur, Haridwar	27-Oct-15	Uttarakhand
UK1	River Alaknanda, Rudra Prayag	Jul-14	Uttarakhand

CLEAN WATER QUALITY INDICATORS OF BENTHIC MACRO-INVERTEBRATES OF CLASS 'A' IN RIVER GANGA

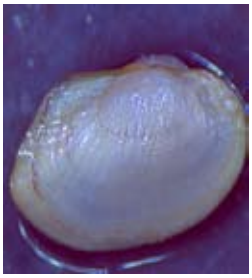
Family	Genera /Species
Aphelocheiridae	*Aphelocheirus*
Baetidae	*Pseudocloeon*
Elmidae	*Stenelmis larva*
Ephemerellidae	*Torleya*
Euphaeidae	*Euphaea decorata*
Gyrinidae	*Orectochilus*
Heptageniidae	*Rhithrogena, Cynigmina,*
Hydropsychidae	*Cheumatopsyche, Hydropsyche*
Leptophlebidae	*Choroterpedes*
Neoephemeridae	*Neoephemeropsis*
Perlidae	*Tetropina*
Physidae	*Physa (Haitia)mexicana*
Psephenidae	*Psephenoidinae*
Salifidae	*Barbronia weberi*
Scritidae	*Cyphon larva*
Simulidae	*Simulium*
Siphlonuridae	*Ameletus*
Tipulidae	*Antocha*





SLIGHT POLLUTION WATER QUALITY LOCATIONS INDICATING CLASS 'B' IN RIVER GANGA

Location code	Name of Location	Duration	State
UK4	Upstream Rishikesh, Luxman Jhula	Nov-15	Uttarakhand
UK5	Barrage, Rishikesh	Nov-15	Uttarakhand
UK6	Haridwar Barrage	June, 2014	Uttarakhand
UK6		Nov-15	Uttarakhand
UK7	Dam Kothi, downstream Har- ki –Pouri	Oct-15	Uttarakhand
UP 40	Bridge downstream River Tons near Sirsa	Feb-15	Uttar Pradesh
BH 13	Sultanganj near Jahaz Ghar	Jan-16	Bihar
WB 1	Upstream Farakka barrage	May-15	West Bengal
WB 3	Downstream FTPS Farakka	May,2015	West Bengal
WB 7	Raghunathganj near bridge	May-15	West Bengal
WB 28	Shibpur Ghat near vidyasagar Setu	Feb-16	West Bengal
UK1	River Alaknanda, downstream Rudraprayag	Nov-15	Uttarakhand
BH 8	River Gandak, Hajipur near rail bridge	Apr-15	Bihar
		Apr-15	Bihar



SLIGHT POLLUTION WATER QUALITY INDICATORS OF BENTHIC MACRO-INVERTEBRATES OF CLASS 'B' IN RIVER GANGA

Atyidae	*Caridina peninsularis, Caridina bruneiana*
Baetidae	*Platybaetis, Baetis*
Belostomatidae	*Lethocerus (=Belostoma), Diplonychus (= Sphaerodema) rusticus*
Bithyniidae	*Digoniostoma pulchella*
Brachycentridae	*Brachycentrus*
Caenidae	*Caenis*
Calopterygidae	*Matrona sp.*
Ceratopogonidae	*Bezzia sp., pupa*
Chironomidae	*Orthocladiinae, Tanypodinae, Chironominae*
Cirolanidae	*Cirolana parva*
Coenagrionidae	*Agriocnemis lacteola*
Corbiculidae	*Corbicula bensoni, Corbicula striatella, Corbicula assamensis*
Corixidae	*Sigara, Corixa, Micronecta, Agraptocorixa*
Dryopidae	*Dryopidae larva*
Dugesiidae	*Dugesia japonica*
Dytiscidae	*Hyphydrus, Nipponhydrus*
Ecnomidae	*Ecnomus*
Elmidae	*Stenelmis, Stenelmis larva*
Ephemerellidae	*Ephemerella Eurylophella, Drunella*
Ephemeridae	*Ephemera/Aethephemera*
Glossiphonidae	*Alboglossiphonia weberi*
Gomphidae	*Heliogomphus, Orientogomphus, Sinictinogomphus*

SLIGHT POLLUTION WATER QUALITY INDICATORS OF BENTHIC MACRO-INVERTEBRATES OF CLASS 'B' IN RIVER GANGA

Heptageniidae	*Rhithrogena, Ironodes,Epeorus, Afronurus, Cynigmina, Epeorus Epeorus*
Histeridae	*Hister*
Hydrophilidae	*Helophorus, Helochares*
Hydropsychidae	*Hydropsyche, Potamiya, Diplectrona, Cheumatopsyche*
Hydroptilidae	*Oxyethira*
Hymenosomatidae	*Neorhynchoplax nasalis juvenile*
Leptophlebidae	*Choroterpes, Choroterpedes*
Libellulidae	*Acisoma, Orthetrum albistylum speciosum, Hydrobasileus, Nannophya pygmea pygmea, Brachythemis, Libellula*
Lumbricidae	*Eiseniella tetraedra tetraedra*
Lymnaeidae	*Lymnaea accuminata*
Mysidae	*Gangemysis assimilis*
Naucoridae	*Ilyocoris, Heleocoris*
Neoephemeridae	*Neoephemeropsis*
Nephthydae	*Nephthys oligobranchia*
Nepidae	*Laccotrphes pfeiferiae*
Nereididae	*Namalycastis indica*
Noteridae	*Hydrocoptus*
Palaemonidae	*Macrobrachium lanatum, Macrobrachium lopopodus, Macrobrachium lar, Macrobrachium lanchasteri, Macrobrachium idea*
Parathelphusidae	*Perithelphusa*
Perlidae	*Flavoperla*
Philopotamidae	*Chimarra*

SLIGHT POLLUTION WATER QUALITY INDICATORS OF BENTHIC MACRO-INVERTEBRATES OF CLASS 'B' IN RIVER GANGA

Physidae	*Physa (Haitia) Mexicana*
Pisioneidae	*Pisionee garciavaldecasai*
Planorbidae	*Indoplanorbis, Gyraulus convexiusculus*
Pleuroceridae	*Brotia costula costula*
Protoneuridae	*Prodesineura autumnalis*
Psephenidae	*Mataeopsephus sp./Psepheninae, Psephenoides magnioculus adult*
Pseudoneuroclipsis	*Incertae sedis*
Ranatrinidae	*Ranatra brevecolis*
Sabellidae	*Caobangia*
Salifidae	*Barbronia weberi*
Sesarmidae	*Sesermops juvenile*
Simulidae	*Simulium*
Siphlonuridae	*Ameletus*
Solecurtidae	*Novaculina gangetica*
Stenopsychidae	*Stenopsyche*
Stenothyridae	*Stenothyra ornata*
Tabanidae	*Tabanus/Atylotus species*

SLIGHT POLLUTION WATER QUALITY INDICATORS OF BENTHIC MACRO-INVERTEBRATES OF CLASS 'B' IN RIVER GANGA

Thiaridae	*Thiara (Sermila) requeti, Thiara (Tarebia) lineata juvenile, Thiara (Tarebia) granifera, Thiara (Thiara)scabra, Melanoides tuberculatus, Melanoides pyramis, Melanoides pyramis juvenile*
Tipulidae	*Antocha*
Unionidae	*Lamellidens corrianus*
Varunidae	*Varuna yui*
Viviparidae	*Bellamya (Filopaludina) bengalensis, Bellamya bengalensis, Mekongia crassa, Idiopoma dissimilis*

MODERATE POLLUTION WATER QUALITY LOCATIONS INDICATING CLASS 'C' IN RIVER GANGA

Location code	Name of Location	Duration	State
UK4	Upstream Rishikesh, Luxman Jhula	Jun-14	Uttarakhand
UK 8b	Downstream Haridwar JSTP	Oct-15	Uttarakhand
UP 1	Balawali, rail and road bridge, upstream Bijnore	Dec-14	Uttar Pradesh
		Apr-16	Uttar Pradesh
UP 2	Madhya Ganga Barrage	Dec-14	Uttar Pradesh
		Apr-16	Uttar Pradesh
UP 4	Brij Ghat, Garhmukteshwar	Dec-14	Uttar Pradesh
		May-16	Uttar Pradesh
UP 6	Bridge, upstream Anupshahr	Dec-14	Uttar Pradesh
		May-16	Uttar Pradesh
UP 7	Bridge, upstream Narora, Rajghat	Dec-14	Uttar Pradesh
		May-16	Uttar Pradesh
UP 8	Barrage, Narora	Dec-14	Uttar Pradesh
		May-16	Uttar Pradesh
UP 9	Kachla Ghat bridge, Badaun	Dec-14	Uttar Pradesh
		May-16	Uttar Pradesh
UP 14	Bridge, Ghatiaghat, Farrukhabad	Jan-15	Uttar Pradesh
		Jun-16	Uttar Pradesh
UP 18	Bridge, Bithoor	Jan-15	Uttar Pradesh
		Jun-16	Uttar Pradesh
UP 19	Bridge, upstream Kanpur	Jan-15	Uttar Pradesh
		Jun-16	Uttar Pradesh
UP 29	Bridge 2, Kanpur 2, NH 25	Jan-15	Uttar Pradesh
		Jun-16	Uttar Pradesh
UPDG (UP A)	Dhondhi Ghat, downstream Kanpur	Jan-15	Uttar Pradesh
		Jun-16	Uttar Pradesh
UP 32	Bridge near Fatehpur	Feb-15	Uttar Pradesh
		Oct-16	Uttar Pradesh
UP 40	Bridge downstream River Tons near Sirsa	Oct-16	Uttar Pradesh
UP41	Bridge, Allahabad bypass	Feb-15	Uttar Pradesh
		Oct-16	Uttar Pradesh

MODERATE POLLUTION WATER QUALITY LOCATIONS INDICATING CLASS 'C' IN RIVER GANGA

		Oct-16	Uttar Pradesh
UP 51	Bridge, Ramnagar road near Varanasi	Mar-15	Uttar Pradesh
		Oct-16	Uttar Pradesh
UP 53	Bridge NH 2, Varanasi, Rajghat	Mar-15	Uttar Pradesh
		Oct-16	Uttar Pradesh
UP 54	Bathing Ghat 1, Varanasi	Mar-15	Uttar Pradesh
		Oct-16	Uttar Pradesh
UP III*	Vindhyachal Ghat, Mirzapur upstream	Mar-15	Uttar Pradesh
		Oct-16	Uttar Pradesh
UP IV	Mirzapur downstream, after confluence of two drains	Mar-15	Uttar Pradesh
		Oct-16	Uttar Pradesh
UP G	Tarighat downstream Ghazipur	Mar-15	Uttar Pradesh
		Oct-16	Uttar Pradesh
BH 3 (1) (BH 3 IN ROUND 1)	Chausa water intake point, upstream Buxar	Apr-15	Bihar
		Dec-15	Bihar
BH 3	Bridge, Buxar downstream	Dec-15	Bihar
BH 5	Bridge, Danapur , Patna 2, Dhigha rail bridge	Apr-15	Bihar
		Dec-15	Bihar
BH 12 DOWN-STREAM	Bridge, Mahatma Gandhi right, near Gai Ghat	Apr-15	Bihar
BH M	Mokamah near Hathidah rail bridhe	Dec-15	Bihar
BH V	Kastharni Ghat, Munger Fort area, upstream Munger	Jan-16	Bihar
BH VI	Sitakundih village, downstream Munger	Jan-16	Bihar
BH S	Sultanganj near Jahaz Ghat	Jan-16	Bihar

BH 12 UP-STREAM	Gandhi Ghat, upstream Mahatma Gandhi Setu	Apr-15	Bihar
BH K	Kahalgaon	Jan-16	Bihar
JH 1	Brahampur Ghat, upstream Sahibganj	Jan-16	Jharkhand
JH 2	Jahaz Ghat, Water intake point, downstream Sahibganj	Jan-16	Jharkhand
JH 3	Mangal Haat, Syed Bazar, upstream Rajmahal	Jan-16	Jharkhand
JH 4	Ferryghat, downstream Rajmahal	Jan-16	Jharkhand
WB 1	Farakka Barrage, upstream barrage	Feb-16	West Bengal
WB 2	Farakka FTPS	May-15	West Bengal
WB 19	Palta Water intake	Feb-16	West Bengal
WB 21	Ghat, downstream Serampore	May-15	West Bengal
WB 23	Belgharia	May-15	West Bengal

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WB 25	Bali bridge	Feb-16	West Bengal
WB 27	Howrah bridge	Feb-16	West Bengal
WB 28	Shibpur Ghat, Vidyasagar Setu	Feb-16	West Bengal
WB 31	Bata Nagar	Feb-16	West Bengal
WB 32	Uluberia, near Kalibari	Feb-16	West Bengal
WB 34 F	Falta	Feb-16	West Bengal
WB 34	Diamond Harbour	May-15	West Bengal
		Feb-16	West Bengal
WB 35	Haldia	Feb-16	West Bengal
UP 3	Sukartal Ghat, River Saloni	Dec-14	Uttar Pradesh
		May-16	Uttar Pradesh

UP 11 (UP 10 IN SECOND ROUND)	River Ramganga, SH 29, Shahabad	Dec-14	Uttar Pradesh
UP 12	Bridge, River Garra, Sandi	Jan-15	Uttar Pradesh
		Jun-16	Uttar Pradesh
UP 13	Bridge, River East Kali, Kanpur- Farrukhabad road	Jan-15	Uttar Pradesh
		Jun-16	Uttar Pradesh
UP I (UP 17)	River Ramganga before confluence to River Ganga	Jan-15	Uttar Pradesh
		Jun-16	Uttar Pradesh
UP II	River East Kali, before confluence to River Ganga	Jan-15	Uttar Pradesh
		Jun-16	Uttar Pradesh
UP 33	Bridge, River Yamuna, MDR, 26 B, near Rajapur	Feb-15	Uttar Pradesh
		Oct-16	Uttar Pradesh
UP 38	Bridge, River Yamuna, NH 27	Feb-15	Uttar Pradesh
		Oct-16	Uttar Pradesh
UP 39	Bridge, River Tons near Panasa	Feb-15	Uttar Pradesh
		Oct-16	Uttar Pradesh
UP 50	River Varuna at Bridge, SH 98, Varanasi	Mar-15	Uttar Pradesh
		Oct-16	Uttar Pradesh
UP 55 (UP 56 IN FIRST ROUND)	Bridge, River Varuna	Oct-16	Uttar Pradesh
UP 56 (UP 57 IN FIRST ROUND)	River Gomti, Rajwari	Mar-15	Uttar Pradesh
		Oct-16	Uttar Pradesh
BH 4	River Ghagra near Manjhi	Apr-15	Bihar
		Dec-15	Bihar

MODERATE POLLUTION WATER QUALITY LOCATIONS INDICATING CLASS 'C' IN RIVER GANGA

BH SK	River Sone, Koilwar near rail- road bridge	Dec-15	Bihar
BH 8	River Gandak, Hajipur near rail bridge	Dec-15	Bihar
BH 11	Nullah at Patna 3b	Apr-15	Bihar
WB 2	Farakka FTPS	29.2 2016	West Bengal
WB 03	Downstream Farakka FTPS	29.2. 2016	West Bengal
WB 4	Upstream of outlet to natural river	26.2. 2016	West Bengal
WB 5	First inlet stream, River Falgu, from west, NH 34, downstream Farakka	24.2. 2016	West Bengal
WB 6	Second outlet stream, Mirzapur-Ajgarpura road bridge	27.2.2016	West Bengal
WB 7	Raghunathganj near bridge	27.5. 2015	West Bengal
		27.2. 2016	West Bengal
WB 9	Upstream Jiaganj	27.5. 2015	West Bengal
WB 10	Road bridge, Behrampore	26.2.2016	West Bengal
WB 11	Downstream Murshidabad, downstream Behrampore, near Begpur village	27.2. 2016	West Bengal
WB 12	Kalyanpur after confluence Bablah nullah	26.2.2016	West Bengal
WB 13	Katwa	23.5. 2015	West Bengal
		25.2.2016	West Bengal
WB 14	Downstream Nabadwip	23.5. 2015	West Bengal
WB 16	Transmission tower, upstream Tribeni	21.5. 2015	West Bengal
		23.3. 2016	West Bengal
WB 17	Chinsura	21.5.2015	West Bengal
WB 19	Palta Water intake	18.5. 2015	West Bengal
UP 6A/ ZBGP	Mastram Ghat, downstream Anupshahr	16.5.2016	Uttar Pradesh
NA	Narora	4.6.2016	Uttar Pradesh

NL	Anupshahar d/s, near mastram murdaghat	4.6.2016	Uttar Pradesh
rw,	Confluence of River Ganga to Choiya drain, Distt. Bijnore	4.6.2016	Uttar Pradesh
jf,	Downstream of confluence of River Ganga to Choiya drain at Panjabi dera, Distt. Bijnore	4.6.2016	Uttar Pradesh









MODERATE POLLUTION WATER QUALITY INDICATORS OF BENTHIC MACRO-INVERTEBRATES OF CLASS 'C' IN RIVER GANGA

Family	Genera /Species
Aegidae	*Alitropus typus*
Aeshnidae	*Planaeschna*
Amblemidae	*Radiatula olivaria, Radiatula occata, Radiatula occata juvenile, Parreysia viridula, Radiatula caerulea juvenile, Parreysia favidens juvenile, Parreysia favidens favidens, Parreysia favidens chrysis, Parreysia corrugata laevirostris, Parreysia corrugata laevirostris juvenile, Radiatula shurtleffiana, Radiatula caerulea, Radiatula pachysoma, Parreysia favidens pinex, Radiatula gaudichaudi, Radiatula andersoniana*
Ampullariidae	*Pila globosa juvenile*
Ancylidae	*Ferrissia baconi juvenile*
Anthuridae	*Stygocyathura*
Aphelocheiridae	*Aphelocheirus*
Arachnoida	*Water spider*
Arcidae	*Scaphula celox*
Assaminidae	*Assamenia fraincaise, Paludinella, Assimines francesiae 20 juvenile+6 adults, Paludinella (Schuetiella) daengswangi*

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Atyidae	*Caridina bruneiana, Caridina thambipilaii, Caridina peninsularis, Caridina elongapoda, Caridina bakoensis, Caridina temasek, Caridina celebensis, Caridina endehensis, Caridina bakoensis, 2male, 1female, Atydae species unidentified*
Baetidae	*Platybaetis, Baetis*
Belostomatidae	*Diplonychus(=Sphaerodema) rusticus, Lethocerus (=Belostoma)*
Bithynidae	*Gabbia orcula, Digoniostoma pulchella, Gabbia stenothyroides, Digoniostoma cerameopoma, Digoniostoma lithoglyphoides, Digoniostoma pulchella foot*
Caenidae	*Caenis*
Ceratopogonidae	*Bezzia species, Halenine larva*
Chironomidae	*Orthocladiinae, Chironominae, Tanypodinae*
Chlorolestidae	*Megalestes chengi*
Cirolanidae	*Cirolana parva*
Coenagrionidae	*Agriocnemis lacteola, Agriocnemis species*
Conchostrucha	*Cyclestheria hislopi*

MODERATE POLLUTION WATER QUALITY INDICATORS OF BENTHIC MACRO-INVERTEBRATES OF CLASS 'C' IN RIVER GANGA

Corbiculidae	*Corbicula bensoni, Corbicula assamensis, Corbicula striatella, Corbicula striatella juvenile*
Corixidae	*Micronecta, Agraptocorixa, Corixa male,female, Micronecta female, Paracorixa, Sigra*
Corrallanidae	*Corallana grandiventra, Corallana species*
Corydellidae	*Terrestrial reidentified on 15.9.2015*
Crambidae	*Elophila*
Crustacea	*Juvenile crabs*
Culicidae	*Mansonia, Culex pupa, Culex larva, Anopheles larva, Anopheles pupa, Topomyia, Malaya larva*
Curculionidae	*Echinocnemus*
Diptera	*Diptera pupa*
Dryopidae	*Helichus*
Dugesiidae?	*Dugesia sp., Dugesia*
Dytiscidae	*Hyphydrus, Eretes, Oreodytes larvae, Hydrovatus, Hydaticus, Rhantus, Nipponhydrus, Cybister larva, Deronectes larva, Laccophilus, Hydrovatus larva, Dytiscus, Cybister larva, Nannophya pygmea, Uvarus, Hydroporus*
Ecnomidae	*Ecnomus*
Elmidae/Elmididae /Elminthidae	*Elmidae/Elmididae/Elminthidae larva, Pseudamophilus, Stenelmis*
Ephemeridae	*Eatongenia*

MODERATE POLLUTION WATER QUALITY INDICATORS OF BENTHIC MACRO-INVERTEBRATES OF CLASS 'C' IN RIVER GANGA

Ephemeridae	*Adults of Eatongenia*
Ephydridae	*Ephydra sp., Ephydra pupa*
Eulichadidae	*Eulichas (Coleoptera larva)*
Gecarcinucidae	*Lepidothelphusa, Salangathaelphusa juvenile, Lepidothelphusa*
Gerridae	*Metrocoris, Halobates*
Glossiphoniidae	*Alboglossiphonia weberi, Hemiclapsis japonica, Halobdella stagnalis*
Gomphidae	*Sinictinogomphus, Heliogomphus, Macrogomphus, Orientogomphus, Stylurus, Sieboldius, Paragomphus, Nihanogomphus, Lamelligomphus, Orientogomphus, Ictinogomphus, Megalogomphus, Stylurus*
Gyrinidae	*Orectochilus larva, Orectochilus*
Haemadipsidae	*Haemadipsa zeylanica*
Haliplidae	*Haliplus, Haliplidae larva*
Hebridae	*Hebrus, Hyrcanus*
Heptageniidae	*Rhithrogena, Cynigmina*
Hirudinidae	*Hirudinaria maniilensis*
Histeridae	*Hister*
Histriobdellidae	*Stratiodrilus*
Hydrophilidae	*Helophorus, Halochares larva, Berosus, Hydrophilus, Helochares, Berosus larva, Hydrophilus larva, Amphiops?*
Hydropsychidae	*Cheumatopsyche, Hydropsyche, Amphpsyche, Diplectrona*

MODERATE POLLUTION WATER QUALITY INDICATORS OF BENTHIC MACRO-INVERTEBRATES OF CLASS 'C' IN RIVER GANGA

Hymenosomatiae	*Neorhynchoplax nasalis, Neorhynchoplax nasalis juvenile*
Leptoceridae	*Triaenodes, Triplectide, Oecetis*
Libellulidae	*Orthetrum, Nannophya pygmea, Orthetrum albistylum speciosum, Trithemis, Lyriothemis, Sympetrum, Rhyothemis, Sympetrum purvulum, Hydrobasileus, Sympetrum speciosum speciosum, Zyxomma, Tholymis, Tramea, Hydrpbasileus croceus, Brachythemis, Trithemis, Libellula, Nannophya pygmea pygmea, Acisoma, Diplacodes, Rheothemis*
Libellulidae	*Orthetrum albistylum speciosum*
Lumbricidae	*Dendrodrillus rubidus, Eiseniella tetaedra tetraedra*
Lumbriculidae	*Lumbriculus variegatus*
Lymnaeidae	*Lymnaea accuminata, Lymnaea andersoniana simulens, Radix luteola*
Macromiidae	*Macromidia, Macromia*
Mesoveliidae	*Mesovalia*
Muscidae	*Musca domestica pupa*
Mysidae	*Gangemysis assimilis*
Naididae	*Aulophorus hymanae, Nais brestscheri, Nais alpina, Dero dorsalis, Aulodrilus pigueti, Aulophorus flabelliger*

MODERATE POLLUTION WATER QUALITY INDICATORS OF BENTHIC MACRO-INVERTEBRATES OF CLASS 'C' IN RIVER GANGA

Namanereidinae (Nereididae)	*Namanerieis covernicola, Namalocastis abiuma*
Neoephemeridae	*Neoephemeropsis*
Nephthydae	*Nephthys polybranchia, Nephthys oligobranchia*
Nepidae	*Laccotrephes pfeiferiae, Nepa, Nepa juvenile, Nepa nymph*
Nereididae	*Namalycastis indica, Namalycastis fauveli, Dendronereides hteropoda, Namaycastis species, Nereis chilkaensis*
Neritidae	*Neritina (Dostia)violacea, Neritina (Vittina) smithi*
Niphargidae	*Neoniphargus, Neoniphargus indicus dried*
Noteridae	*Canthydrus, Hydrocoptus, Noterus, Neohydrocoptus*
Notonectidae	*Anisops*
Nymphomyiidae	*Nymphomyia*
Onchidiidae	*Onchidium typhae, Onchiium species*
Palaemonidae	*Macrobrachium lopopodus, Macrobrachium horstii, Macrobrachium callirrhoe, Macrobrachium niphanae, Macrobrachium mirabile, Macrobrachium lar, Macrobrachium idea, Macrobrachium clymene, Palaemonidae species unidentified, Macrobrachium callirrhoe*
Parathelphusidae	*Perithelphusa, Perithelphusa juvenile*

MODERATE POLLUTION WATER QUALITY INDICATORS OF BENTHIC MACRO-INVERTEBRATES OF CLASS 'C' IN RIVER GANGA

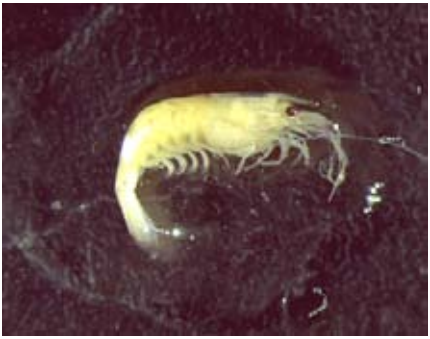
Physidae	*Physa (Haitia) Mexicana*
Pisioneidae	*Pisione garciavaldecasai, Pisione*
Planorbidae	*Gyraulus convexiusculus, Indoplanorbis, Hippeutis umbilicalis, Ameriana, Gyraulus labiatus, Segmentina calatha, Gyraulus labiatus*
Pleidae	*Paraplea or Plea fontalis, Paraplea*
Pleuroceridae	*Brotia costula costula*
Polycentropodidae	*Polycentropus*
Potamidae	*Johora, Isolapotamon, Sesarmidae*
Protoneuridae	*Prodasineura autumnalis*
Pseudoneuroclipsis	*Incertae sedis pupa*
Psychodidae	*Psychoda, Peripsychoda*
Psychomyiidae	*Lype*
Pyralidae	*Paraponyx, Nymphula, Paraponyx diminutalis*
Ranatrinidae	*Ranatra brevecolis, Ranatra*
Sabellidae	*Manayunkia/ Brandtika, Caobangia,*
Salifidae	*Barbronia weberi*
Sarcophagidae	*Sarcophaga*
Scirtidae	*Prionocyphon, Cyphon, Cyphon larva*
Septariidae	*Septaria tesselata, Septaria species*

MODERATE POLLUTION WATER QUALITY INDICATORS OF BENTHIC MACRO-INVERTEBRATES OF CLASS 'C' IN RIVER GANGA

Sesarmidae	*Sesarmoides,9adults,16 juvenile, Sesarmops female with eggs, Pseudosesarma, Geosesarma, Sesarmoides, Sesarmops juvenile*
Siphonuridae	*Ameletus*
Solecurtidae	*Noviculana gangetica juvenile, Novaculina gangetica*
Spaeriidae	*Pisidium (Afropisidium) clarkeanum, Pisidium atkinsonianum, Pisidium annandalei, Pisidium (Odhneripisidium) prasongi, Musculium indicum*
Sphaerlidae	*Sphaerlidae (semiaquatic)*
Stenasellidae	*Stenasellus*
Stenothyridae	*Stenothyra ornata, Stenothyra deltae, Gangetia miliacea*
Stratiomyidae	*Beris larva, Stratiomys sp., Oxycera, Nemotelus*
Succineidae	*Quickia sp., Succinia dead shell*
Syrphidae	*Eristalis sp.*
Tabanidae	*Tabanus/Atylotus sp. sp./Atylotus sp.*
Talitridae	*Platorchetia platensis*

MODERATE POLLUTION WATER QUALITY INDICATORS OF BENTHIC MACRO-INVERTEBRATES OF CLASS 'C' IN RIVER GANGA

Thiaridae	*Melanoides pyramis juvenile, Melanoides pyramis leopardina, Thiara (Tarebia) lineata, Thiara(Thiara)scabra, Melanoides tuberculatus, Thiara (Sermyla)requeti, Melanoides pyramis leopardina, Thiaridae juvenile*
Thiaridae	*Melanoides pyramis, Melanoides tuberculatus, Melanoides pyramis, Thiara (Sermyla) requeti, Thiara (Thiara) scabra, Thiara (Tarebia) lineata, Thiara(Tarebia) granifera*
Tipulidae	*Antocha, Hexatoma*



MODERATE POLLUTION WATER QUALITY INDICATORS OF BENTHIC MACRO-INVERTEBRATES OF CLASS 'C' IN RIVER GANGA

Tubificidae	*Limnodrilus udekemianus, Branchiodrilus semperi, Branchiodrilus sowerbyi, Aulodrilus pluriseta, Bothrioneurum vejdovskyanum, Limnodrilus Hoffmeisteri, Spirosperma nagarkotensis, Aulodrilus pigueti, Aulodrilus limnobius, Ilyodrilus templetoni, Branchiodrilus hortensis, Spirosperma nagarkotensis*
Unionidae	*Lamellidens phenchooganjensis, Lamellidens sp. Juvenile, Lamellidens rhadineus, Lamellidens marginalis, Lamellidens sp. Juvenile, Lamellidens rhadineus juvenile, Lamellidens corrianus, Lamellidens lamellatus, Lamellidens mainwaringi, Lamellidens corrianus, Lamellidens narainporensis, Lamellidens lamellatus*
Varunidae	*Varuna juvenile, Varuna yui, Varuna, varuna species*
Velidae	*Rhagodotarsus kraepelini, Rhagovelia singaporensis*
Viviparidae	*Mekongia crassa, Bellamya bengalensis, Bellamya bengalensis juvenile, Mekongia crassa juvenile, Idiopoma dissimilis*
	Unidentified Coleoptera
	Unidentified Diptera
	Unidentified insect
	Unidentified Oligochaete
	Unidentified Oligochaete

HEAVY POLLUTION WATER QUALITY LOCATIONS INDICATING CLASS 'D' IN RIVER GANGA

Location code	Name of Location	Duration	State
UK 8b	Downstream Haridwar JSTP	June 2014	Uttarakhand
BH 12 Downstream	Bridge Mahatma Gandhi right near Gai Ghat	December 2015	Bihar
WB 14	Downstream Nabadwip	February 2016	West Bengal
WB 15	Upstream Tribeni	May 2015	West Bengal
UP 10(UP 10 M in second round)	River Ramganga, downstream Muradabad	December 2014	Uttar Pradesh
UP 10(UP 10 M in second round)		December 2014	Uttar Pradesh
UP 10(UP 10 M in second round)		May 2016	Uttar Pradesh
UP 11(UP 10 in second round)	River Ramganga, SH 29, Shahabad	May 2016	Uttar Pradesh
UP 55(UP 56 In first round)	Bridge, River Varuna, Varanasi	March 2015	Uttar Pradesh

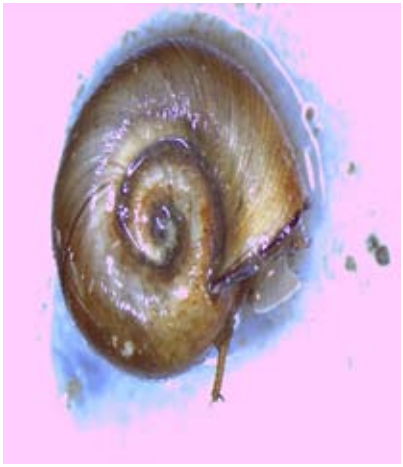
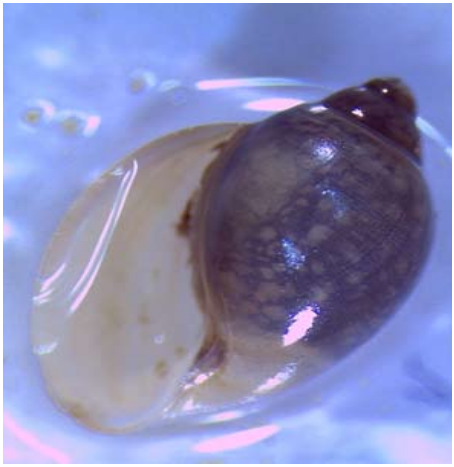
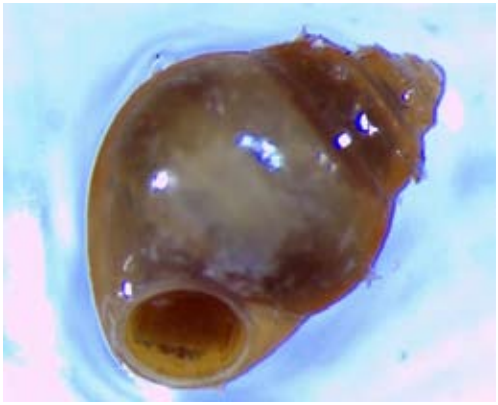
HEAVY POLLUTION WATER QUALITY INDICATORS OF BENTHIC MACRO-INVERTEBRATES IN CLASS 'D' IN RIVER GANGA

Family	Genera /Species
Amblemidae	*Parreysia favidens juvenile*
Atyidae	*Caridina temasek*
Belostomatidae	*Diplonychus (= Sphaerodema)rusticus rusticus*
Bithyniidae	*Digoniostoma pulchella juvenile*
Chironomidae	*Chironominae*
Corbiculidae	*Corbicula bensoni, Corbicula striatella*
Corixidae	*Micronecta, Corixa, Agraptocorixa*
Culicidae	*Anopheles larva*
Dytiscidae	*Hyphydrus, Nipponhydrus, Laccophilus, Hydrovatus*
Elmidae/Elmididae/ Elminthidae	*Elmidae/Elmididae/Elminthidae larva*
Gomphidae	*Sinictinogomphus*
Histeridae	*Hister*
Hydrophilidae	*Helophorus, Helochares, Hydrophilus, Hydrophilus larva, Berosus larva*
Lymnaeidae	*Lymnaea accuminata*
Naididae	*Branchiodrilus semperi, Allonais inaequalisis, Aulodrilus pluriseta, Aulodrilus pigueti, Haemonais waldvogeli*

Nepidae	*Laccotrephes pfeiferiae pfeiferiae, Nepa*
Nereididae	*Namalycastis indica*
Noteridae	*Canthydrus, Noterus, Hydrocoptus*
Physidae	*Physa (Haitia) mexicana*
Pisioneidae	*Pisionee garciavaldecasai*
Planorbidae	*Gyraulus convexiusculus, Indoplanorbis, Segmentina trochoidae*

HEAVY POLLUTION WATER QUALITY INDICATORS OF BENTHIC MACRO-INVERTEBRATES OF CLASS 'D' IN RIVER GANGA

Ranatrinidae	*Ranatra brevecolis*
Sabellidae	*Caobangia*
Sphaeriidae	*Pisidium (Aropisidium) clarkeanum*
Stenothyridae	*Stenothyra ornata*
Thiaridae	*Melanoides pyramis juvenile, Melanoides pyramis, Melanoides tuberculstus, Thiara (Tarebia) lineata*
Tubificidae	*Limnodrilus hoffmiesteri*
Viviparidae	*Bellamya bengalensis*



SEVERE POLLUTION WATER QUALITY LOCATIONS ANDINDICATORS OF BENTHIC MACRO-INVERTEBRATES OF CLASS 'E' IN RIVER GANGA

Location code	Name of Location	Duration	State	Family	Genera / Species
None	None			None	None

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