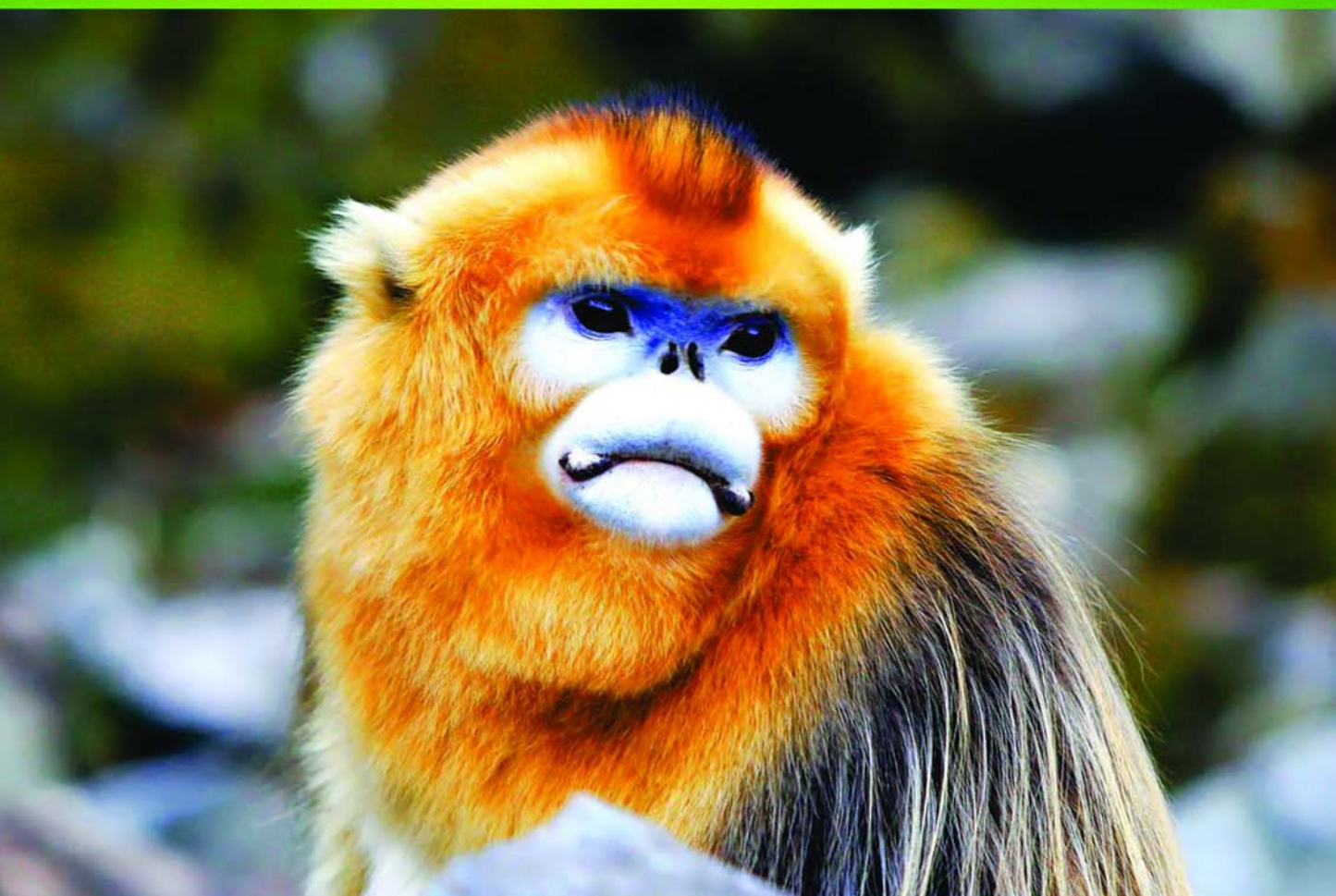


ISSN 1000-0933
CN 11-2031/Q

生态学报

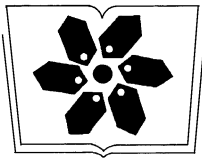
Acta Ecologica Sinica



第32卷 第2期 Vol.32 No.2 **2012**

中国生态学学会
中国科学院生态环境研究中心
科学出版社

主办
出版



中国科学院科学出版基金资助出版

生态学报

(SHENGTAI XUEBAO)

第 32 卷 第 2 期

2012 年 1 月 (半月刊)

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期刊基本参数:CN 11-2031/Q * 1981 * m * 16 * 330 * zh * P * ¥ 70.00 * 1510 * 37 * 2012-01	



封面图说: 雄视——中国的金丝猴有川、黔、滇金丝猴三种,此外还有越南和缅甸金丝猴两种。金丝猴是典型的森林树栖动物,常年栖居于海拔 1500—3300m 的亚热带山地、亚高山针叶林、针阔叶混交林,常绿落叶阔叶混交林中,随着季节的变化,只在栖息的生境中作垂直移动。川金丝猴身上长有柔软金色长毛,十分漂亮。个体大,嘴角处有瘤状突起的是雄性金丝猴的特征。川金丝猴只分布在中国的四川、甘肃、陕西和湖北省。属国家一级重点保护、CITES 附录一物种。

彩图提供: 陈建伟教授 国家林业局 E-mail: cites.chenjw@163.com

DOI: 10.5846/stxb201012081751

韩鸣花, 于海燕, 周斌, 张勇, 王备新. 城市溪流中径流式低坝对底栖动物群落结构的影响. 生态学报, 2012, 32(2): 0380-0385.

Han M H, Yu H Y, Zhou B, Zhang Y, Wang B X. The impact of run-of stream dams on benthic macroinvertebrate assemblages in urban streams. Acta Ecologica Sinica, 2012, 32(2): 0380-0385.

城市溪流中径流式低坝对底栖动物群落结构的影响

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摘要:调查了浙江省安吉县内具径流式低坝的城市溪流(6个样点)和参照溪流(3个样点)的底栖动物群落,目的是了解城市溪流底栖动物群落结构退化规律和径流式低坝(2—3 m)对城市溪流底栖动物群落组成与结构的影响。结果表明,参照样点的底质组成以大石块(35.92%)和卵石(33.66%)为主,城市溪流以砾石为主(57.97%)。城市溪流水温和电导率显著高于参照溪流, TN 和 TP 高于参照溪流。底栖动物总分类单元数和 EPT 分类单元数显著低于参照溪流。城市溪流河道内水坝上下游之间的流速($P=0.273$)和宽深比($P=3.92$)无显著差异。坝下游水体中的 TP 高于坝上游,电导率、溶解氧、pH 值和水温在坝上下游之间几乎一致。除 BI 指数坝下游高于坝上游外,坝上下游间底栖动物总分类单元数、EPT 分类单元数以及多样性指数、优势度和均匀度指数没有显著差异。但坝下游的耐污类群比例显著高于坝上游,敏感类群比例则显著低于坝上游。与坝上游相比,坝下游捕食者比例上升和集食者比例下降。NMDS 结果进一步表明,城市溪流内水坝的建设导致坝上下游底栖动物群落物种组成明显改变。

关键词:径流式低坝;城市溪流;大型底栖无脊椎动物

The impact of run-of stream dams on benthic macroinvertebrate assemblages in urban streams

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Abstract: Study of the degradation of urban stream ecosystems has been an important focus of urban ecology. During urbanization, infrastructure such as dams and other water projects can have a significant impact on the stream ecosystem. Dams create barriers, upstream and downstream, which hinder the migration of benthic invertebrates, change their living environment and affect their reproductive success, negatively affecting the macroinvertebrate community and its structure. This destroys the integrity of the stream ecosystem. To date, there has been no published research on this topic in China. Therefore, we surveyed the macroinvertebrate assemblages of nine sites (six in urban streams with run-of stream dams [2—3m] and three in reference forest streams) in August, in Xitiao River catchment, Anji County, Zhejiang Province. Using the data collected, we explored the biological degradation of urban streams and the impact of run-of stream dams on the structure and composition of the macroinvertebrate community as well as on a range of biochemical parameters. Multiple comparison and non-parametric tests were used to compare the biochemical parameters of the different stream types, performed using SPSS 18.0 statistical software. Non-metric multidimensional scaling (NMDS) analysis was used to compare the community composition, performed using Primer 6.0 software. Our results showed that the main substrate components of the reference sites were boulders (35.92%) and cobbles (33.66%), while the substrate of the urban streams was mostly

基金项目:国家自然科学基金项目(30870345)

收稿日期:2010-12-08; 修订日期:2011-04-26

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gravel (57.97%). Water temperature, conductivity, and concentrations of total nitrogen and total phosphorous were all significantly ($P < 0.05$) higher in urban streams than in reference streams, whereas total taxa richness and EPT (Ephemeroptera, Plecoptera and Trichoptera) taxa richness were significantly ($P < 0.05$) lower in the urban streams than in the reference streams. Differences in velocity ($P = 0.273$) and depth/width ($P = 3.92$) between sites above and below the dams were not significant. Dissolved oxygen, pH, total nitrogen concentration, water temperature and conductivity were also very similar between sites above and below the dams. An exception to this was that total phosphorus concentration was greater below the dams than above the dams. Moreover, total taxa richness, EPT taxa richness, Shannon diversity index and evenness index of the sites above and below the dams were similar. However, the biotic index was higher below dams than above dams. In addition, the ratio of sensitive taxa to tolerant taxa was lower at sites below dams, and the ratio of predators to collector-gatherers was higher at the sites below dams. Furthermore, NMDS analysis demonstrated that the macroinvertebrate community composition greatly varied between the sites above and below the dams in these urban streams. These results suggested that the sediment composition, water quality and benthic community structure had been significantly degraded in urban streams, particularly downstream of the dams. These observations are preliminary since they are based on a survey conducted in August only, and therefore do not allow comprehensive assessment of the ecological effects of dam constructions. However, our findings indicate that there may be negative impacts and support the need for regular and long-term observations of the macroinvertebrate community in urban streams with dams.

Key Words: run-of stream dams; urban stream; macroinvertebrate assemblages

城市溪流生态系统退化是目前城市生态影响研究的重要内容之一^[1]。城镇化引起的城市溪流水文的剧烈变化^[2-3]、污染物和营养物的增多^[4],以及生境质量下降^[3],是城市溪流底栖动物群落组成与结构退化的主要原因。随着我国城镇化进程的加速,城市溪流生态质量退化已越来越严重^[5]。

水坝对溪流生态系统的影响研究早在 1979 年就开始了^[6],也是目前溪流生态学关注的热点之一^[7]。水坝切断了溪流上下游之间的连通性,改变了上下游水文情势^[8],阻碍了生物的迁移以及运动,造成水坝下游物种多样性丧失^[9-10]。但是有关水坝对溪流生物群落组成与结构的影响研究集中在国外,国内研究很少^[11]。而径流式低坝(坝高小于 3 m 的溢流式坝)对城市溪流生态系统的影响,国内外都尚未见相关报道,虽然径流式低坝已成为国内城市溪流中最常见的基础设施之一。本文目的是了解城市溪流河道内径流式低坝(2—3 m)对城市溪流底栖动物群落组成与结构的影响。研究结果有助于科学评价城市溪流内径流式低坝的生态效应,为城市溪流生态系统的修复和保护提供建议。

1 材料与方法

1.1 研究区域概况

研究区域位于浙江省湖州市安吉县境内的西苕溪流域。调查了具径流式水坝的 2 条溪流,共 3 个高小于 2 m 的水坝的上下游样点各 3 个(图 1),水坝上下游样点都位于安吉县城。另外选择了 3 个参照样点。参照点位于龙王山和天锦堂,参照样点上游流域及周边人类活动干扰很小,上游流域的土地利用皆为林地。

1.2 样本采集

1.2.1 水体理化性状

采样区域位于 100 m 长的河段,水坝下游选择流水生境采样。2009 年 8 月,用 HANNA 水质检测仪(HI98129、

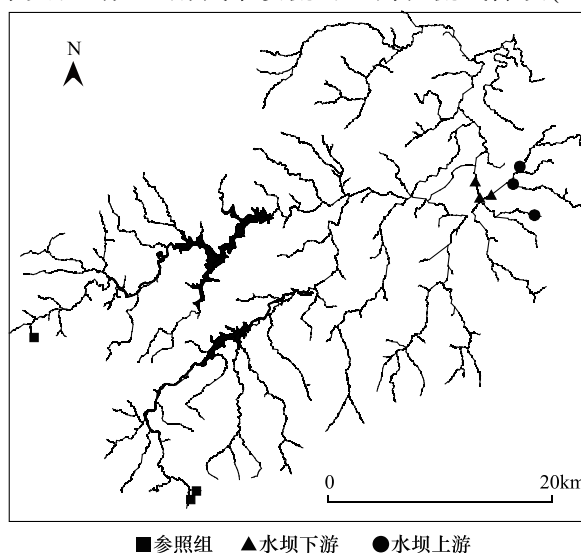


图 1 9 个采样点的具体位置

Fig. 1 Location of nine studied sites in Xitiao river catchment

HI9147)现场测定 pH 值、水温、电导和溶解氧。按 GB3838. 2002GB《地表水环境质量标准》采集水样带回实验室测定,总氮(TN)采用紫外分光光度法、总磷(TP)采用钼蓝法、化学需氧量(COD)采用高锰酸钾法^[12]。

1.2.2 大型底栖无脊椎动物采集

用索伯网(250 μm, 0.09 m²)在所选溪流点位采 5 个样方(3 个急流样,2 个缓流样)。所采标本直接在野外用 40 目钢筛筛选,并用 5%—10% 的福尔马林液固定后带回实验室。标本一般鉴定到属或种,并记录每个分类单元(属、种)的个体数。

1.2.3 数据处理与分析

试验数据采用 Excel 2003 进行整理。Shannon-Wiener 多样性指数、Simpson 指数和均匀度指数参照马克平等^[13]的方法。大型底栖动物取食功能团参照 Merritt 和 Cummins^[14]的分类方法。采用 SPSS 18.0 统计软件,分别利用最小显著性差异(LSD)多重比较方法和非参数检验,对 3 种不同类型溪流的理化和生物参数进行分析。运用 Primer 6.0 软件对 9 个样点的底栖动物群落进行 NMDS 分析。

2 结果与分析

2.1 溪流生境属性

根据 Barbour 等^[15]的底质分类标准将底质分为沙和淤泥(<2 mm)、砾石(2—64 mm)、鹅卵石(64—256 mm)和大石块(>256 mm)4 个区间。3 种不同类型样点的底质组成所占百分比表明(图 2),参照样点的底质组成以大石块(35.92%)和卵石(33.66%)为主,水坝上游样点的底质组成以砾石(82.28%)为主,水坝下游样点的底质组成同样以砾石为主(66.37%),水坝下游沙和淤泥(6.79%)百分比较水坝上游(4.96%)略有增加。水坝上下游及参照样点间的水的平均流速及河道深宽比之间皆没有显著差异(表 1)。

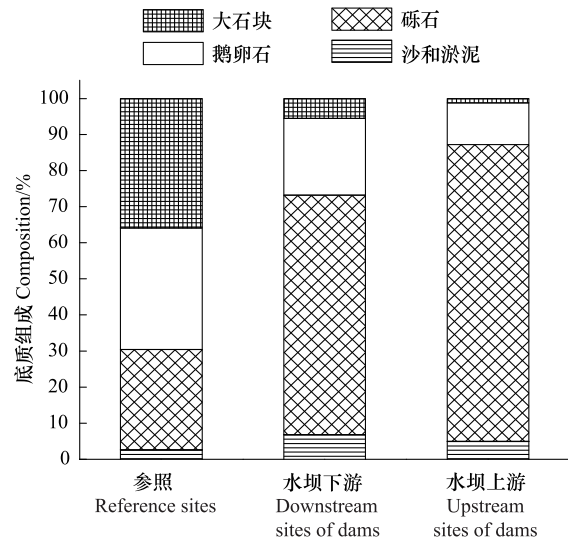


图 2 不同类型样点的底质组成比例

Fig. 2 The substrate compositions of upstream and downstream sites of dams and reference sites

表 1 水坝上下游和参照样点的流速和深宽比

Table 1 The current velocity and depth/width of upstream and downstream sites of dams and reference sites

参数 Parameter	参照 Reference sites	水坝下游 Downstream sites of dams	水坝上游 Upstream sites of dams	P	F
流速 Velocity/(m/s)	0.63±0.30	0.75±0.20	0.65±0.10	0.273	0.770
深/宽 Depth/Width	0.14±0.09	0.04±0.02	0.03±0.01	3.920	0.081

2.2 水体理化性质

城市溪流(水坝上下游)的水温和电导率显著高于参照溪流。虽然 TP 和 TN 也高于参照溪流,但仅水坝下游的 TP 显著高于参照溪流(图 3)。城市溪流的溶解氧要低于参照溪流,但差异不显著。pH 值在参照溪流和城市溪流间无显著变化。水坝上下游样点间的 TN、TP、pH 值、溶解氧、水温和电导率之间无显著差异(图 3)。

2.3 底栖动物群落结构

本次调查共采集大型底栖无脊椎动物 45 科 98 属共 114 个分类单元。其中昆虫纲共 7 目 92 个分类单元,占有底栖动物种类的 80.70%。昆虫个体数共 5432 头,占有底栖动物数量的 90.74%。另外,软体动物门 9 个分类单元(占 7.89%),环节动物门 9 个分类单元(占 7.89%),甲壳纲 3 个分类单元(占 2.63%)。

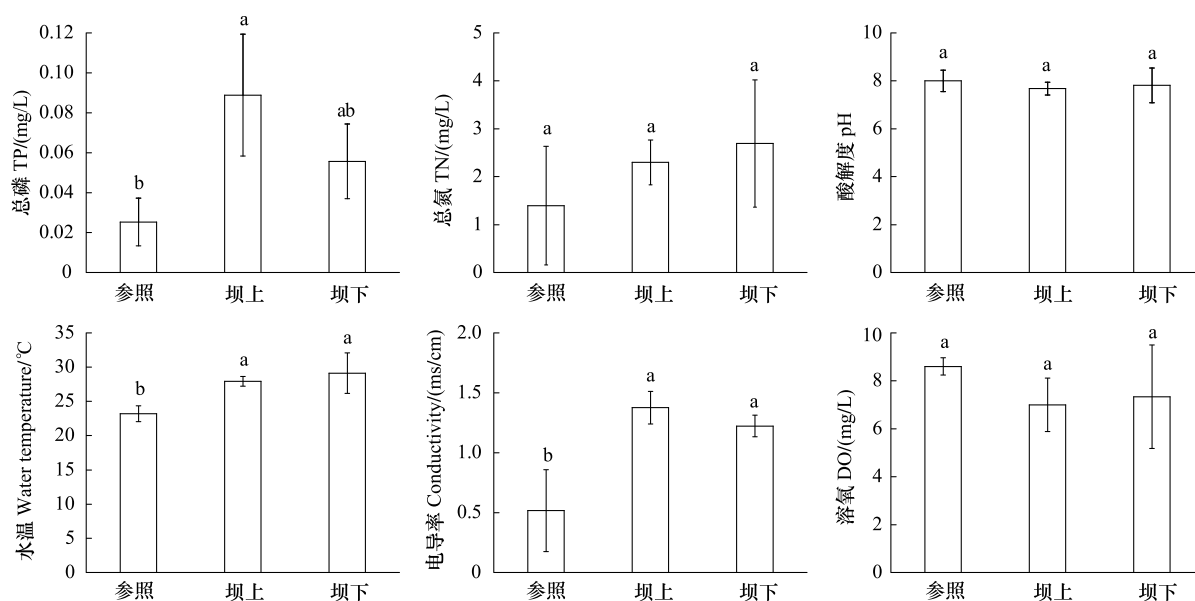


图3 水坝上下游和参照样点间的 TP、TN、pH、水温、电导率和溶氧的 ANOVA 多重比较结果

Fig. 3 The TP, TN, pH, water temperature, conductivity and DO of upstream and downstream sites of dams, and reference sites (mean \pm SD)

不同字母表示差异显著 ($P < 0.05$), 相同字母表示差异不显著 ($P > 0.05$)

参照样点的总分类单元数和 EPT 分类单元数显著高于城市溪流样点 (图 4A); BI 指数显著低于城市溪流。参照样点的香农多样性指数显著高于坝上游, 但与坝下游无显著差异。优势度和均匀度指数均无显著差异 (图 4B)。参照样点的滤食者比例显著高于城市溪流; 而撕食者比例则显著高于坝上游, 但与坝下游无显著差异 (图 4C)。参照样点的敏感类群比例显著高于城市溪流。耐污类群比例显著低于坝下游, 但与坝上游无显著差异 (图 4D)。

水坝上下游样点的总分类单元数、EPT 分类单元数基本没有差异 (图 4A)。坝下游 BI 指数高于坝上游。多样性指数、优势度和均匀度指数, 坝上下游之间基本没有差异 (图 4B)。坝下游撕食者比例 (5.55%) 显著高于坝上游 (0.08%); 坝下游捕食者以及刮食者比例较坝上游高; 集食者比例较坝上游低 (图 4C)。坝下游的敏感类群几乎消失 (0.52%), 显著低于坝上游 (3.36%); 坝下游耐污类群百分比 (27.82%) 显著高于坝上游 (2.80%) (图 4D)。

NMDS 结果表明 (stress value = 0.05), 参照溪流的大型底栖无脊椎动物在群落组成上与其它两种类型的溪流有明显的差异。水坝下游的底栖动物群落组成除铜山桥样点外, 其余 2 个样点与水坝上游溪流有较明显的差异。

3 讨论

Walsh 等人^[3]详细归纳了西方国家城市溪流退化的共性表现, 包括氮磷营养盐升高, 温度升高, 底栖动物群落组成中耐污类群比例上升和敏感类群比例的下降。本研究同样表明 (图 3), 城市溪流内 6 个样点的水温、TN 和 TP 高于参照溪流。城市溪流底栖动物群落中敏感类群比例显著下降, 耐污类群比例在水坝下游样点显著上升。研究还发现, 城市溪流底栖动物群落丰富度如总分类单元数和 EPT 分类单元数显著低于参照溪流, 城市溪流的 BI 指数显著高于参照溪流, 这与 Chadwick^[16]等人的研究一致。城市溪流的滤食者比例的显著降低, 则可能与大多数的滤食者如纹石蛾, 都是不耐污的种类, 与城市溪流污染较重有一定关系。但与大多数研究结果不同的是^[17-18], 水坝下游样点的撕食者比例 (5.55%) 高于参照样点 (2.80%), 其原因主要是水坝下游出现了耐污能力强的栉水虱, 且个体数量较多。城市溪流水体水温和氮磷营养盐的升高、以及底质组成多样性的下降与城市溪流底栖动物群落组成和结构的退化有着必然的联系。

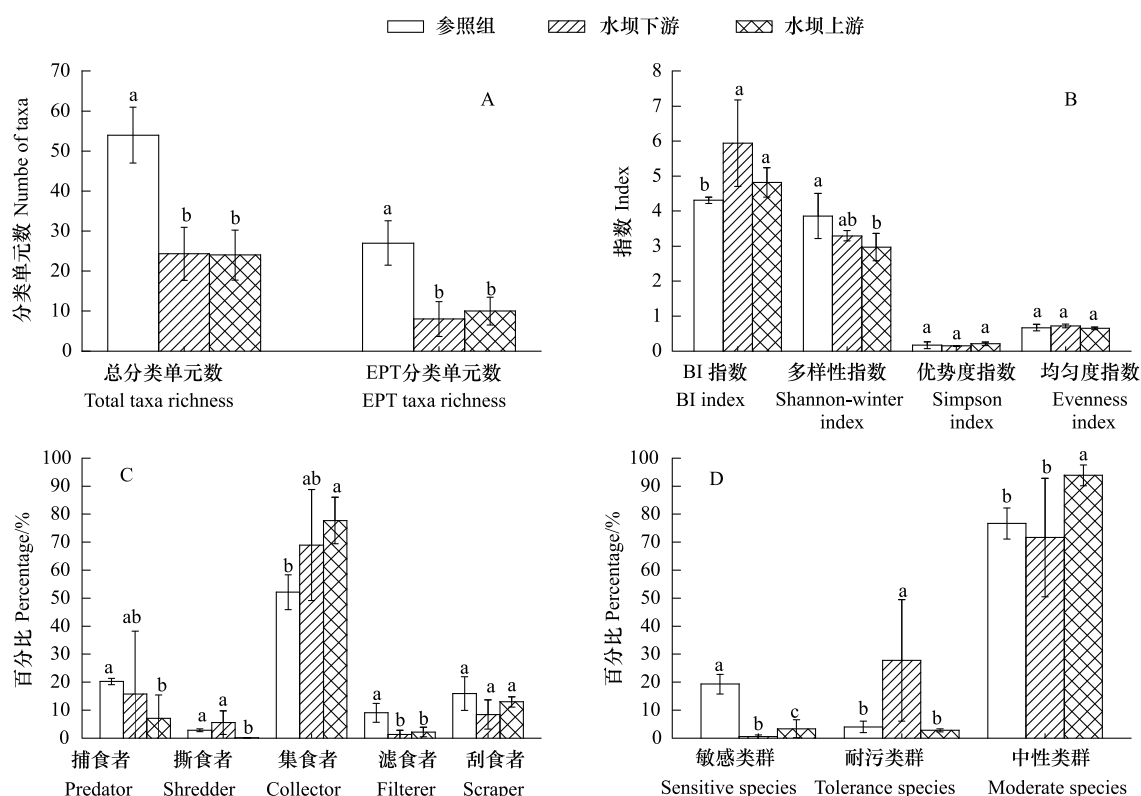


图4 不同类型样点溪流底栖动物群落参数的 ANOVA 的非参数比较结果

Fig. 4 The macroinvertebrate metrics of upstream and downstream sites of dams and reference sites

相同字母表示差异性不显著 ($P > 0.05$), 不同字母表示差异性显著 ($P < 0.05$)

水坝对上下游样点间的底质组成、水体的理化性质和底栖动物群落组成与结构的影响受水坝大小^[7]和水坝类型(径流式或下泄式)不同而差异很大^[10, 17]。水坝上下游之间的流速没有明显差异($P = 0.273$),这可能与8月份是雨季有一定关系。下游底质组成中大石块的比例较高,主要是由于坝下游遗留了较多的大型水泥块等建筑垃圾。坝下游水体中的TP和电导率高于上游,溶解氧、pH值和水温之间几乎一致,而TN则是水坝上游要高于下游。说明水坝建设对坝上下游溪流水体理化性质的影响很小,这与Almeida等人^[10]的研究结果类似。

在底栖动物群落组成与结构方面,坝下游的耐污类群比例显著高于坝上游,说明坝的建设对底栖动物群落结构产生了影响。耐污类群比例的增加则可能与水质有关,如坝下游TP浓度(0.09 mg/L)要高于坝下游TP浓度(0.06 mg/L),这与Gowns^[11]的结果类似。BI指数坝下游要高于坝上游,同样说明坝下游受到的干扰要强于坝上游。已有研究都表明,受建坝影响,坝下游撕食者比例会下降^[17-18],但本文的结果却是坝下游撕食者比例要高于坝上游,可能与坝下游遗留的大型建筑垃圾为栉水虱提供了合适的生存场所有关。研究与Vallania等^[18]人研究一致的是坝下游捕食者比例上升和集食者比例下降,不一致的是刮食者比例下降而不是上升。这可能与坝下游受污染重有关。其它生物参数,如总分类单元数、EPT分类单元数、多样性指数、优势度和均匀度指数,坝上下游之间则没有差异,进一步说明水

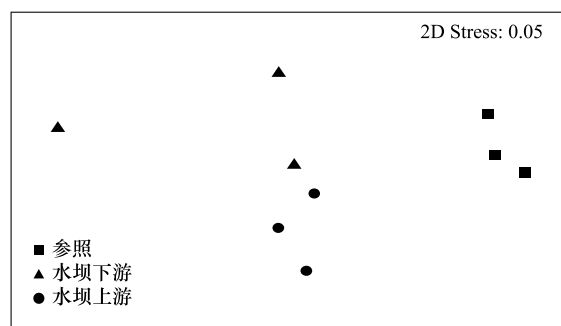


图5 不同类型样点的非度量多维尺度排序图

Fig. 5 The 2-dimensional NMDS ordinal configuration of the upstream and downstream sites of dams and reference sites

坝对底栖动物群落的影响主要体现在组成群落物种的相似性上,这与 NMDS 的结果一致。在未来研究中,定期和长期观察数据是必须的。

总之,与参照溪流相比,城市溪流底质组成、水质和底栖动物群落结构发生了显著退化。溪流水坝建设导致坝上下游底栖动物群落组成的明显改变,坝下游捕食者比例上升和集食者比例下降,坝下游耐污类群比例显著增高。

References:

- [1] McDonald R I. Global urbanization: can ecologists identify a sustainable way forward? *Frontiers in Ecology and the Environment*, 2008, 6(2): 99-104.
- [2] Booth D B. Challenges and prospects for restoring urban streams: a perspective from the Pacific Northwest of North America. *Journal of the North American Benthological Society*, 2005, 24(3): 724-737.
- [3] Walsh C J, Roy A H, Feminella J W, Cottingham P D, Groffman P M, Morgan R P II. The urban stream syndrome: current knowledge and the search for a cure. *Journal of the North American Benthological Society*, 2005, 24(3): 706-723.
- [4] Hatt B E, Fletcher T D, Walsh C J, Taylor S L. The influence of urban density and drainage infrastructure on the concentrations and loads of pollutants in small streams. *Environmental Management*, 2004, 34(1): 112-124.
- [5] Stepenuck K F, Crunkilton R L, Wang L Z. Impacts of urban landuse on macroinvertebrate communities in southeastern wisconsin streams. *Journal of the American Water Resources Association*, 2002, 38(4): 1041-1051.
- [6] Ward J V, Stanford J A. *The Ecology of Regulated Streams*. New York: Plenum Press, 1979, (33757): 409-409.
- [7] Poff N L, Hart D D. How dams vary and why it matters for the emerging science of dam removal. *BioScience*, 2002, 52(8): 659-668.
- [8] Ligon F K, Dietrich W E, Trush W J. Downstream ecological effects of dams. *BioScience*, 1995, 45(3): 183-192.
- [9] Benstead J P, March J G, Pringle C M, Scatena F N. Effects of a low-head dam and water abstraction on migratory tropical stream biota. *Ecological Applications*, 1999, 9(2): 656-668.
- [10] Almeida E F, Oliveira R B, Mugnai R, Nessimian J L, Baptista D F. Effects of small dams on the benthic community of streams in an atlantic forest area of southeastern brazil. *International Review of Hydrobiology*, 2009, 94(2): 179-193.
- [11] Grouns I, Reinfelds I, Williams S, Coade G. Longitudinal effects of a water supply reservoir (Tallowa Dam) on downstream water quality, substrate and riffle macroinvertebrate assemblages in the Shoalhaven River, Australia. *Marine and Freshwater Research*, 2009, 60(6): 594-606.
- [12] The Eutrophication Survey Research of Lake, Reservoir All Over the Country Work Group. *The Eutrophication Survey Criterion of Lake*. Beijing: China Environment Science Press, 1987: 142-171.
- [13] Qian Y Q, Ma K P. *Biodiversity Principles and Methods*. Beijing: China Environment Science Press, 1994: 141-165.
- [14] Merritt R W, Cummins K W, Berg M B. *An Introduction to the Aquatic Insects of North America*. Dubuque: Kendall/Hunt Publishing Company, 1996.
- [15] Barbour M T, Gerritsen J, Griffith G E, Frydenborg G R, McCarron E, White J S, Bastian M L. A framework for biological criteria for florida streams using benthic macroinvertebrates. *Journal of the North American Benthological Society*, 1996, 15(2): 185-211.
- [16] Chadwick M A, Dobberfuhl D R, Benke A C, Huryn A D, Suberkropp K, Thiele J E. Urbanization affects stream ecosystem function by altering hydrology, chemistry, and biotic richness. *Ecological Applications*, 2006, 16(5): 1796-1807.
- [17] Rader R B, Ward J V. Influence of regulation on environmental conditions and the macroinvertebrate community in the upper Colorado River. *Regulated Rivers: Research and Management*, 1988, 2(5): 597-618.
- [18] Vallania A, Corigliano M D C. The effect of regulation caused by a dam on the distribution of the functional feeding groups of the benthos in the sub basin of the Grande River (San Luis, Argentina). *Environmental Monitoring and Assessment*, 2007, 124(1/3): 201-209.

参考文献:

- [12] 全国主要湖泊、水库富营养化调查研究. 课题组. 湖泊富营养化调查规范. 北京: 中国环境科学出版社, 1987: 142-171.
- [13] 钱迎倩, 马克平. 生物多样性研究的原理与方法. 北京: 中国环境科学技术出版社, 1994: 141-165.

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国内邮发代号:82-7 国外邮发代号:M670 标准刊号:ISSN 1000-0933 CN 11-2031/Q

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编辑部主任 孔红梅 执行编辑 刘天星 段 靖

生 态 学 报
(SHENGTAI XUEBAO)
(半月刊 1981 年 3 月创刊)
第 32 卷 第 2 期 (2012 年 1 月)

ACTA ECOLOGICA SINICA
(Semimonthly, Started in 1981)
Vol. 32 No. 2 2012

编 辑	《生态学报》编辑部 地址:北京海淀区双清路 18 号 邮政编码:100085 电话:(010)62941099 www.ecologica.cn shengtaixuebao@rcees.ac.cn	Edited by	Editorial board of ACTA ECOLOGICA SINICA Add:18, Shuangqing Street, Haidian, Beijing 100085, China Tel:(010)62941099 www.ecologica.cn Shengtaixuebao@rcees.ac.cn
主 编	冯宗炜	Editor-in-chief	FENG Zong-Wei
主 管	中国科学技术协会	Supervised by	China Association for Science and Technology
主 办	中国生态学学会 中国科学院生态环境研究中心 地址:北京海淀区双清路 18 号 邮政编码:100085	Sponsored by	Ecological Society of China Research Center for Eco-environmental Sciences, CAS Add:18, Shuangqing Street, Haidian, Beijing 100085, China
出 版	科 学 出 版 社 地址:北京东黄城根北街 16 号 邮政编码:100717	Published by	Science Press Add:16 Donghuangchenggen North Street, Beijing 100717, China
印 刷	北京北林印刷厂	Printed by	Beijing Bei Lin Printing House, Beijing 100083, China
发 行	科 学 出 版 社 地址:东黄城根北街 16 号 邮政编码:100717 电话:(010)64034563 E-mail:journal@cspg.net	Distributed by	Science Press Add:16 Donghuangchenggen North Street, Beijing 100717, China Tel:(010)64034563 E-mail:journal@cspg.net
订 购	全国各地邮局	Domestic	All Local Post Offices in China
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广告经营 许 可 证	京海工商广字第 8013 号		



ISSN 1000-0933
CN 11-2031/Q

国内外公开发行

国内邮发代号 82-7

国外发行代号 M670

定价 70.00 元