

Biodegradation of Persistent Chlorinated Hydrocarbons Using Selected Freshwater Bacteria

(O %HVWZ\0DQV\ \$\$WWDQG =DKUDQ +
'HSDUWPHQW RI (QYLURQPHQWDO 6WXGLHV ,QVWLWXWH RI *UDGXDW 6WXGLHV DQG 5HVHDFK \$OH[DQ
&XUUHQW \$GGUHV 'HSDUWPHQW RI /LIH 6FLHQFH)DFXOW\ RI 6FLHQFH .LQJ \$EGXO \$]L 8QLYHUVLW\ :
&HQWUDO /DERUDWRU\ RI 3HVWLFLGHV \$JULFXOWXUDO 5HVHDFK &HQWHU DW 6DEDKLD \$OH[DQGLD (,
'HSDUWPHQW RI (QYLURQPHQWDO %LRWHFKQRORJ\ &LW\ IRU 6FLHQWLILF 5HVHDFK DQG 7HFKQRORJ\ \$\$
&RUUHVSRLQGLD \$%MKRZ\ ('HSDUWPHQW RI (QYLURQPHQWDO 6WXGLHV ,QVWLWXWH RI *UDGXDW 6W
6KDWE\ \$OH[DQGLD (J\SW 7HO RU HEYD\H VDPHOEHV(WDZ\#\DKRR FRP
5HF GDWH \$FF GDWH 0D\ 3XE GDWH 0D\
&RSULJKW ((O %HVWZ\ (HW DO 7KLV LV DQ RSHQ DFFHVV DUWLFOH GLVWULEXWHG XQGHU WH
XQUHVWULFWHG XVH GLVWULEXWLRQ DQG UHSURGFWLRQ LQ DQ\ PHGLXP SURYLGHG WKH RULJLQDO D

\$EVWUDFW
,VROD\HDFWLRQ RI SRWHQW GHJUDGDWLYH PLFURRUJDQLVPV DJDLQV QDWX
DV D SRZHUHO PHDQV IRU HQYLURQPHQWDO GHWR[LILFDWLRQ ,Q WKH SUHVHQW
DQG LGHQWLILHG IURP D KHDYLO\
ZHUH LQYHVWLJDWHG DV ELRGHJUDGHU GXULQJ WKH SUHVHQW ZRUN \$OVR WKH DELOLW\ RI
WKH JE p HVP -0€`pÀ`Àp€`0PL\WXUH ''7 ''(/LQGDQH DQG (QGLQ RQ WKH EDFWHULD JURZWK D
WLRQ ZDV IRXQG WR EH D IXQFWLRQ RI WKH SHVWLFLGH PL\WXUH FRQFHQWUDWLRQ EDFWHULD

.H\ZRUG%LRGHJUDGDWLRQ &KORULQDGHGURJUDGDWLRQV *HURZWK WKXV SRVH
,QKLELWLRQ 3HVWLFLGHV :DWHU SROXWREORFZHYHU ''(DQG LWV XQFKORUL
GLSKHQ\OHQH '3(ZDV IRXQGVWURGXFWRQ
,QWURGXFWRQ
DFLGRYRU@QVRUHRXGABPRQVWQZQ DV D S
GHJUDGHU WR Ž +H\DFKORURF\FORKH\DQH
+DORJHQDWHG DOLSKDWLF FRPSRXQGV @DQG P\WLO\FBQ@LPHURWRQENPV
UHFDOFLWUDQW LQ PDQ\ VXEVXUIDFH HQYLURQPHQWV VXFK DV VRLOV
VHGLPHQWV DQG JURXQG ZDWHUV GXH\WPHWDLXWFKYRFXW6 RW\$EHLQWLOGLY
SDUW WR WKH ODFN RI DSSURSULDWH PLFURRUJDGHUHQYLURQPHQWDOGHJUDGHU
> @)RU H\DPSON ''7 DQG LWV GHJUDGDWLRQ SURGXFWV FRQWUX\HUV EH
GHWHFWHG LQ WKH DTXDWLF DQG WHUHVWULFDOSRQXWLRQLOFOXGLXORXPDQ
GHFDGHV DIWHU WKHLU DSSOLFDWLRQ SURVHWV V\XG@ WKF LQVHDFKOBWLVV
UHSUHVHQWV D JUHDW WKUHDW VLQFH IURP PNHODULXWV DZWHQDQWRIL DQG
HVWURJHQLF DQG FDQ DOWHU UHSURGFWLRQHQYHWDWGHGFRQFHQWUDWLRQVWKH UDF
PDPPDOV > @ 7KHUHIRUH UPHGLDWLRQ RY WKH HQYLURQPHQW XVLOJ VHOH
ELRGHJUDGDWLRQ FRQVLGHUHG DV DQ LQWHQVLYH UHTXLUPHQW WR PLQLPL]H
WKH QHJDWLYH FRQVHTXHQFHV RI SHVWLFLGHV DQG PHWKRGV
%LRORJLFDQ DJHQWV PHGLDWH WKH PRYV VLJQLILFDQW GHJUDGDWLRQ RI
RUJDQLF FRPSRXQGV LQ WKH QDWXUDO HQYLURQPHQW 9HU\ RIWHQ RUJDQLF
FRPSRXQGV VXFK DV SHVWLFLGHV DUH GHJUDGHU\TXORWLDOLWKSURKOKWKH
DFWLYLW\ RI D VHULHV RI GLIIHUHQW RULJLQDWHG KHLRBAQGHJUDGHUHQYL
QDWXUH DUH PLFURRUJDQLVPV PRVWO\ EDFWHULD DQG VRPH IXQJL > @ 7KH
UDWH DW ZKLFK SHVWLFLGHV DUH GHJUDGHG YDULHV ZLGHQ\ IURP GD\ WR \HDU
LQ VRPH FDVHV ''7 ''(DQG OLQGDQH FKDUDFWHUL]HG E\ ORZ

SUHVHQW VWXG\ 7KH\ ZHUH VHOHFWHG EDVHG RQ WKHLU DYDLODELOLW\ LQ /
ODULXW VRXWK RI \$OH[DQGGULD ZKLFK H[FHHGV WKHLU OHYHOV LQ WKH PRVW
SROOXWHG ODNHV ZRUOGZLGH 6WRFN DQG VWDQGDUG VROXWLRQV RI ''7 ''(
/LQGDQH DQG (QGULQ ZHUH SUHSDUHG IRU *DV &KURPDWRJUDSK\ *&
DQDO\VLV LQ Q KH[DQH \$QDODU %'+ JUDGH (QJODQG 7KH\ ZHUH
H[DPLQHG DV PL[WXUHV DW WZR HOHYDWHG OHYHOV DQG PJ O EDVHG
RQ WKHLU OHYHOV LQ / ODULXW

0LFURRUJDQLVPV

\$V D UHVXOW RI WKH LQWHQVLYH SROOXWLRQ / ODULXW FRQVLGHUHG DV DQ
H[WUHPH HQYLURQPHQW ZKHUH LWV ELRWLF HOHPHQWV PLFUR DQG PDFUR
KDYH EHHQ VKLIWHG WR KLJKO\ UHVLVWDQW VSHFLHV 'XULQJ WKH SUHVHQW VWXG\
ILYH GLIIHUHQW EDFWHULD VSHFLHV ZHUH VHOHFWHG IURP WKH ,QVWLWXWH
*UDGXDW 6WXGLHV DQG 5HVHDUFK ,*65 FROOHFWLRQ WR LQYHVWLJDWH WKHLU
ELRGHJUDGDWLRQ FDSDELOLWLHV IRU WKH VHOHFWHG SHVWLFLGHV 7KH\ ZHUH
RULJLQDOO\ LVRODWHG IURP 3VHOHFWLRQV DQG LGHQWLILHG DV
FHSDF\LDWHUREDF\OHUHU@DQDO\SKIO RFXUFXW
\$UWKURVDF\OHUHU@ 7KHLU RFXUHQFH LQ /
ODULXW V HQYLURQPHQW ZKLFK FKDUDFWHUL]HG E\ YHU\ KLJK OHYHOV RI
SHVWLFLGHV UHIOHFWV WKHLU UHVLVWDQFH WR VXFK W\SH RI SROOXWLRQ

3UHSUDWLRQ DQG FXOWXULQJ FRQGLWLRQV

)RU HDFK VSHFLHV WKUHH IODVNV FRQWDLQLQJ QXWULHQW EURWK PO
HDFK[RGL(QJODQG ZHUH SUHSDUHG VWHULOL]HG DQG KHDYLO\
LQRFXODWHG \$IWHU LQRFXODWLRQ WKH WKUHH FXOWXUHV RI WKH ILYH VSHFLHV
LQFXEDWHG LQ D VKDNHU LQFXEDWHG DIWHU USP DQG
ZKLFK SHVWLFLGHV ZHUH DGGHG 2QH RI WKH WKUHH UHSOLFDFWHV ZDV XVHG DV
FRQWURO FXOWXU ZKHUH QR SHVWLFLGHV ZHUH DGGHG 7KH RWKHU WZR ZHUH
LQMHFWHG ZLWK WKH ORZ DQG KLJK FRQFHQWUDWLRQV RI WKH VHOHFWHG SHVWLFLGHV
DV PL[WXUHV UHVSFWLYHO\ \$OO WKH WUHDWHG DQG WKH XQWUHDWHG FXOWXUHV
ZHUH LQFXEDWHG IRU DQRWKHU K XQGHU WKH VDPH FRQGLWLRQV \$IWHU
LQFXEDWLRQ D VSHFLILF IUDFWLRQ IURP HDFK FXOWXU LQFOXGLQJ WKH FRQWURO
ZDV DVHSWLFDOO\ GUDZQ DQG XVHG IRU DQDO\]LQJ UHVLGXDO FRQFHQWUDWLRQ
WKH SHVWLFLGHV DV ZHOO DV WKH LQKLELWLRQ LQ WKH JURZWK RI WKH VHOHFWHG
EDFWHULD 7KHQ VDPH RI WKH WUHDWHG DQG XQWUHDWHG FXOWXUHV ZHUH
GUDZQ HYHU\ K IRU VXFFHVVLYH GD\ DQG VXEMHFWHG WR WKH VDPH
DQDO\VLV 6XUYLYDO RI WKH VHOHFWHG PLFUREHV IRU WKH H[SHULPHQW GXUDWLRQ
GD\ LV DWULEXWHG WR WKH XVH RI WKH QXWULHQWV LQ WKH ULFK PHGLXP
WKH ILUVW K DQG WKH XVH RI SHVWLFLGHV DV VROH FDUERQ DQG HQHUJ\
VRXUFHV DIWHU VXSSOHPHQW WR WKH WUHDWHG FXOWXUHV 7KLV ZDV FRQILUP
ODWHU E\ WKH JUHDW DELOLW\ RI VXFK EDFWHULD WR GHJUDGH WKH KLJKO\
UHFDOLWUDQW SHVWLFLGHV VHOHFWHG %HVLGH WKHVH EDFWHULD ZHUH DGDSDU
H[WUHPH SROOXWLRQ DQG VWDUYDWLRQ FRQGLWLRQV ZKHUH WKH\ FDQ VWDQGDUG
VXUYLYH 7KLV FDQ H[SODLQ WKH YLDELOLW\ RI RXU VHOHFWLRQ WUHDWHG DV
FRQWURO IRU VXFK VKRUW SHULRG RI WLPH GD\ LV KLJKO\ H[SHFWHG

,QKLELWRU\ HIIHFW RI FKORULQDWHG SHVWLFLGHV RQ EDFWHULD
JURZWK

FRQGLWLRQV 7KH FRQFHQWUDWLRQ RI WKH WHVWHG FRPSRXQGV RU PHWDEROLV
''(ZDV WKHQ FDOFXODWHG E\ FRPSDULQJ LWV WRWDO DUHD ZLWK WKH WRWDO
DUHD RI WKH VWDQGDUG GHWHFWHG LQVHFVLFV

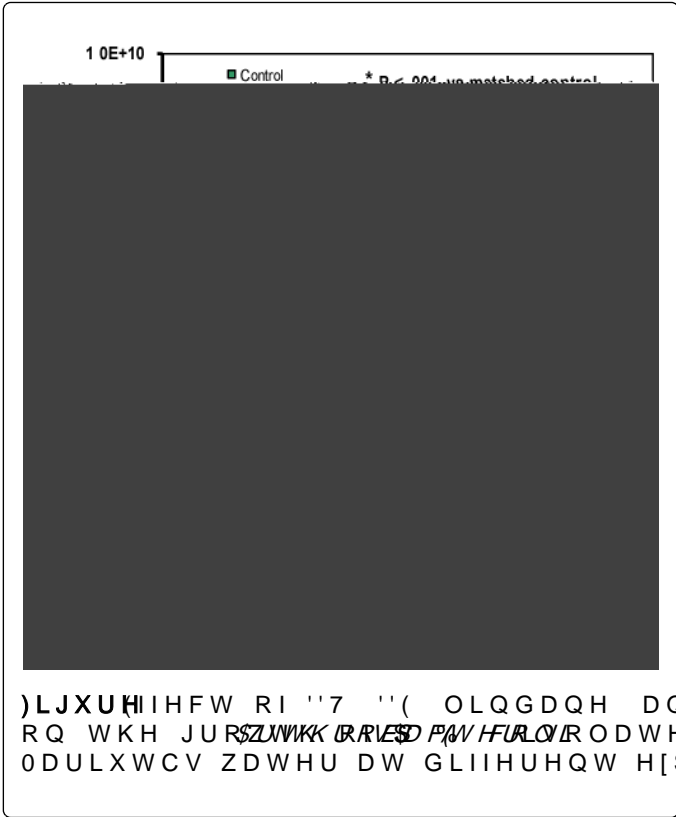
6WDWLWVLFDO DQDO\VLV

%DFWHULDO FRXQV Z&HHPORRQGLWVHFWVJWR
\$129\$ XVLQJ 6WDWLWVLF 9HUVLRQ 6WDW 6RIW ,Q 7XVOD 2. 86\$
0HDQV VWDQGDUG HUURU DQG WKH OHDVW VLJQLILFDQFH EHWZHHQ WKH PHDQV
ZHUV GHWHUPLQH S

5HVXOWV DQG GLVFXVLRQ

,QKLELWRU\ HIIHFV RI FKORULQDWHG SHVWLFLGHV RQ EDFWHULDO
JURZWK

0HDVXUHPHQWV RI JURZWK LQKLELWLRQ WKH YLDELOLW\ RI EDFWHULDO FHOH
DQG WKH HIIHFV RQ UHVSLUDWLRQ DQG RWKHU EDFWHULDO PHWDEROLF SDUDPH
KDYH EHHQ XVHG DV VKRUW WHUP ELRORJLFDO VFUHHQLQJ WHVWV RI WR[LFLW
> @ 8QGHU WKH FRWUROOHG H[SHULPHQWDO FRQGLWLRQV WKH FRPELQH
HIIHFV RI WKH VHOHFWHG SHVWLFLGHV RQ WKH LQGLYLGXDO LVRODWHG VSHFL
UHPDUNDEOH 'HQVLWLHV &)8 PO RI WKH VHOHFWHG EDFWHULD GXULQJ WKH
ELRGHJUDGDWLRQ DVVD\ DUH SUHVHQWHG RQ WKHLU ILJXUV DQG 7KHVH



)LJXUHIHFW RI ''7 ''(OLQGDQH DQG HQGULQ DV D PL[WXUH
RQ WKH JURSZWK BRLES PAVH FURQV RODWHG IURP /
ODULXWCV ZDWHU DW GLIIHUHQW H[SRVXUH WLPHV

\$W WKH ORZHVW FRQFHQWUDWLRQ SSP

*HQHUDOO\ DOO RI WKH VHOHFWHG VSHFLHV H[KLELWHG VXSHULRU FDSDELOLV
WR GHJUDGH DOO RI WKH H[DPLQHG FRPSRXQGV DW WKDW FRQFHQWUDWLRQ ZLW
GHJUDGDWLRQ HIILFLHQF\ UDQJHG EHWZHHQ DQG)LJXUHV
7KH\ DOVR H[KLELWHG VHOHFWLYH EHKDYLRU IRU GHJUDGDWLRQ GHSHQGV RQ
EDFWULDQ VSHFLHV FKHPFDQ VWUXFWXUH RI WKH FRPSRXQGV DV ZHOO DV
H[SRVXUH ~~WLPHV~~ RQ WKH WRS ZLWK D VXSHULRU DELOLV
UHDFKHG GHJUDGDWLRQ RI DOO WKH WHVWHG FRPSRXQGV DW D YHU\ IDW
UDWH ZKHUH QRQH RI WKHP ZHUH GHWHFWHG LQ WKH JURZWK PHGLXP DIWHU WKH
ILUVW K DQG WKURXJKRXW WKH H[SHULPHQW 7KLV ZDV IROORZHG E\
~~DXU~~ KLVFK KDG GHJUDGDWLRQ IRU DOO WKH FRPSRXQGV DIWHU K
H[FHSW IRU OLQGDQH DOWKRXXJK DFKLHYLQJ KLJK GHJUDGDWLRQ HIILFLHQF\
DQG DIWHU RQH WZR DQG WKUHH H[SRVXUH GD\V
UHVSHFWLYH ~~WLPHV~~ ZHG VLPLODU UHVXOWV ZLWK KLJKHU
HIILFLHQFLHV IRU OLQGDQH DQG DIWHU WKH VDPH FRQWDFW WLPH
UHVSHFWLYH ~~WLPHV~~ ZHG JUHDW GHJUDGDWLRQ HIILFLHQF\ WRZDUGV WKH
PRVW UHFDOFLWUDQW FRPSRXQGV VHOHFWHG ''7 ''(HQGULQ DQG
OLQGDQH UHDFKHG ~~WLPHV~~ ZHG WKH VDPH
UHVXOWV IRU ''7 ''(DQG OLQGDQH EXW QHHHG ORQJHU FRQWDFW WLPH
GD\V WR DFKLHYH GHJUDGDWLRQ IRU HQGULQ ZKHUH LW GHJUDGHG
DQG RI WKH FRPSRXQGV DIWHU RQH WZR DQG WKUHH GD\V
UHVSHFWLYHO\

\$W WKH KLJKHVW FRQFHQWUDWLRQ SSP

,W ZDV H[SHFWHG WKDW RQH WKRXVDQG IROG LQFUHDVHV LQ WKH SHVWLFLGH
FRQFHQWUDWLRQ ZLOO UHPDUNDEO\ UHGXFH WKH GHJUDGDWLRQ HIILFLHQF\ E\ W
VHOHFWHG RUJDQLVPV +RZHYHU RQO\ VOLJKW GHFUHDVH ZDV LQGXFHG

7HFKQRORJ\ ,QVWLWXWH RI *UDGXDWH 6WXGLHV 5HVHDFK \$OH[DQGLD
8QLYHUVLW\ \$OH[DQGLD (J\SW
&OHVHU*WHHQEHUJ &* (DWRQ '\$' 6WDQGDUG PHWKRQ IRU WKH
H[DPLQDWLRQ RI ZDWHU DQG ZDVWHZDWHU WK HGQ \$PHULFDQ 3XEOLF
+HDWK \$VVRFLDWLRQ \$3+\$:DVKLQJWRQ
(UQVW : 6FK*~~DR~~HHUHUH5&