

0DODULD DPRQJ WKH *HULDWULF 3RSXODWLRQ 3UHYDOHQFH &RPSOLFDWLRQV DQG &R PRUELGLW

&KXNZXRFKD 80 XNZXRFKD 80 GXMLK 2* \$PDGL &1 1ZRNH (\$ DQG ,EHK 612
'HSDUWPHQW RI 3XEOLF +HDOWK 7HFKQRORJ\)HGHUO 8QLYHUVLW\ RI 7HFKQRORJ\ 2ZHUUL 1LJHULD
&RUUHVSRLQGLQJ &KXNZXRFKD 80 'HSDUWPHQW RI 3XEOLF +HDOWK 7HFKQRORJ\)HGHUO 8QLYHUVLW\ RI
FKXNZXRFKDXFKHP#\DKRR FRP
5HFHLYHG GDUWFK \$FFHSWHG GDSME OLSMLKFCSSGIDWH
&RS\ULJKW < &KXNZXRFKD 80 HW DO 7KLV LV DQ RSHQ DFFHVV DUWLFOH GLVWULEXWHG XQGHU W
XQUHVWULFWHG XVH GLVWULEXWLRQ DQG UHSURGXFWLRQ LQ DQ\ PHGLXP SURYLGHG WKH RULJLQDO D

\$EVWUDFW

7KLWVXG\ ZDV GRQH WR DVFHUWDLQ PDODULD SUHYDOHQFH LWV FRPSOLFDWLRQ
GLVHDSVHV DPRQJ WKH JHULDWULF SRSXODWLRQ LQ SDUW RI 6RXWK (DVWHUQ 1
EHWZHHQ WKH DJHV RI DQG \HDUV ZHUH UHFUXLWHG LQ ,KLDJZD 6RXWK (DVW
FROOHFWHG IURP WKHP ZHUH *LHPVD VWDLQHG DQG H[DPLQHG PLFURVFRSLFDOO\
LQ DGGLWLRQ WR KHDOWK IDFLOLW\ UHFRUGV DQDO\VLV ZHUH GRQH WR GHWHUPLQ
FR PRUELGLW\ ZLWK QRQ FRPPXQLFDEOH GLVHDSVHV

7KHUH ZDV KLJK PDODULD SUHYDOHQFH DPRQJ VWXG\ VXEMHFWV 5HVSLUDWRU
FRPSOLFDWLRQ DVVRFLDWHG ZLWK LW ZKLOH 'LDEHWHV 0HOOLWV ZDV
FRPPXQLFDEOH GLVHDSVHV 7KH ROGHU DGXOWV VKRXOG EH DGHTXDWHO\ LQFOXG
LQYHVWLJDWLRQV LQWR WKH SDWWHUQ G\QDPLFV DQG IDFWRUV UHODWLQJ WR
GLVHDSVHV DPRQJ WKLV DJH JURXS VKRXOG EH JLYHQ XUJHQW DWWHQWLRQ

.H\ZRUGV 0DODULD *HULDWULF SRSXODWLRQ 3UHYDOHQFH
&RPSOLFDWLRQV &R PRUELGLW\

,QWURGXFWRQ

0DODULD RFFXUV DOPRVW H[FOXVLYHO\ LQ WKH WURSLFV DQG VXEWURSLFV DQ
DSSUR[LPDWHO\ RI WKH ZRUOGdV SRSXODWLRQ PRVWO\ WKR VH OLYLQJ LQ WKH
ZRUOGdV SRRUHVW FRXQWULHV DUH DW ULVN RI PDODULD (YHU\ \HDU PRUH WK
PLOOLRQ SHRSOH EHFRPH VHYHUHO\ LOO ZLWK PDODULD a PRVW FDSVHV DQG
GHDWKV RFFXU ZLWKLQ VXE 6DKDUDQ \$IULFD > @

H ZRUOG KHDOWK RUJDQLJDWLRQ DQG WKH :RUOG EDQN UDQNHG PDODULD
DWKH ODUJHVW VLQJOH FRPSRQHQW RI WKH GLVHDSVHV EXUGHQ LQ \$IULFD
FDXVLQJ DQ DQXDO ORVV RI PLOOLRQ IXWXUH OLIH \HDUV IURP GLVDELOLW\
DQG SUHPDWXUH PRUWOLW\ > @ ,Q \$IULFD PDODULD LV UHVSRLQVLEOH IRU
DERXW RI KRVS LWDO DGPLVVLRQV DQG DERXW RI RXWSDWLHQW
FRQVXOWDWLRQV > @

0DODULD LV D PDMRU FDXVH RI PRUELGLW\ DQG PRUWOLW\ LQ 1LJHULD ,W LV
HQGHPLF WKURXJKRXW WKH FRXQWULHV VHDVLRQDO YDULDWLRQV LQ
JRQH RI WKH FRXQWU\ \$W OXDMWRP RQH WKH SRSXODWLRQ
HSVRGH RI PDODULD HDFK \HDU LV DOVR WKH FRPPRQHVW FDXVH RI
RXWSDWLHQW KRVS LWDO DWWHQGDQFH > @

ORVW UVRZDUGV PDODULD PDQDJHPHQW DQG FRQWURO DUH DLPHG DW
XGHYHFKLOGUHQ DQG SURJUDQQWKRERRRQGHU DJH
FDWHJRULHV DUH QRW DGHTXDWHO\ FRQVLGHUHG LQ PRVW RI WKHVH SURJUDPV
DPRXQWLQJ WR VRPH NLQG RI QHJOHFW IRU WKR VH LQ WKH ROGHU DJH JURXS

\$OWKRXXJK HYLGHQFH VXJJHVWV WKDW FOLQLFDO LPPXQLW\ WR PDODULD
GHYHORSU\SRVXUH WR SDUDVLWHV DV RQH SURJUHVVHV LQ DJH WKLV
LPXQLW\ LV RQO\ SDUW DQDQDQ PD\ EH
E

LVVWXG\ LQYHVWLJDWHG WKH PDODULD SUHYDOHQFH FRPSOLFDWLRQV DQG
FR PRUELGLW\ ZLWK QRQ FRPPXQLFDEOH GLVHDVHV DPRQJ WKH JHULDWULF
SRSXODWLRQ LQ ,KLDJZD 6RXWK (DVWHUQ 1LJHULD

0DWHULDOV DQG 0HWKRGV

6WXG\ VHWLQJ DQG SRSXODWLRQ

LVVWXG\ ZDV FDUULHG RXW LQ ,KLDJZD FRPPXQLW\ KHDOWK FHQWHU ,PR
6WDWH 6RXWK (DVWHUQ 1LJHULD /DWLWXGH 1 DQG
/RQJLWXGH (KDV D WRWDO SRSXODWLRQ RI DERXW SHRSOH DV RI
WKH FHQVXV DQG FRYHUV DQ DUHD RI VTXDUH NLORPHWHUV

,W LV ORFDWHG LQ WKH WURSLFDO UDLQ IRUHVW ZLWK FOLPDWLF DQG
HQYLURQPHQWDO FRQGLWLRQV WKDW UHSHW SRUW PDODULD
VWXG\ SRSXODWLRQV ZHUH WKRVH DERYH \HDUV RI DJH WKDW SUHVHQWHG DV
WKH KHDOWK XEMHFWV ZHUH UHFUXLWHG E\ VLP SOH EDOORWLQJ HDFK
GD\ XQWLO WKH WDUJHW SRSXODWLRQ RI VXEMHFWV ZDV UHDFKHG

+RZHYHU LQ WKH FRXUVH RI WKH VWXG\ VXEMHFWV GLHG DQG RSWHG RXW
OHDYLQJ XV ZLWK VXEMHFWV HIRU WKDW WKH
VXEMHFWV ZHUH DVVRFLDWHG ZLWK FRPSOLFDWLRQV DULVLQJ IURP WKH DLOPHQ
WKH SUHVHQWHG ZLWK LQ WKH KHDOWK IDFLOLW\

4XHVWLRQQDLUHV ZHUH XVHG WR FROOHFW VRFLRGHPRJUDSKLF GDWD IURP
WKH FRQVHQWLQJ VWXG\ VXEMHFWV

6DPSOH FROOHFWLRQ DQG SDUDVLWRORJLF H[DPLQDWLRQ

7HUWLDU\		
7RWDO		
2FFXSDWLRQDO 6WDWXV		
)DUPHU		
'ULYHU		
&LYLO VHUYDQW		
8QHPSOR\HG		
7RWDO		

7DEOH

0DOH				
)HPDOH				
DERYH				
0DOH				
)HPDOH				
7RWDO				

7DEOH VWULEXWLRQ RI PDODULD SDUDVLWH LQWHQVLW\

ORUH IHPDOHV ZHUH LQIHFWHG WKDQ PDOHV
 ZLWK UHVLVHDMWRDWH RULHV RI \HUV
 \HUV DQG \HUV

\$JH 0DODULD GHQVLW\LDEHWHV PHOOLWXV +\SHUWHQVLRQ	1HRSKURSDWK\	2WKHU 1RQ FRPPXQLFD GLVHDSVH
\UV		
\UV		
\UV		
\UV DQG DERYH		
7RWDO		
*UDQG WRWDO	SDUDVLWHV LQ HYHU\ KLJK SRZHU ILHOG	SDUDVLWHV SHU K

7DEOH 0DODULD FR PRUELGLW\ ZLWK QRQ FRPPXQLFD EOH GLVHDSVH
E d. 1

'LVFXVVLRQ

ZHUH DVVRFLDWHG ZLWK FRPSOLFDFWLRQV
LQYROYHPHQW DQG \$QDPLD 3UHYLXV V
PHSOLFDFWLRQV DFRPSHRSOH RI ROGHU
LVVWXG\ KDV VKRZQ D KLJK SUHYDERF
JHULDWULFV LQ 6RXW SUHDOHQFH ZDVKRUG
ERWK VHIHV DQG DFURVV DOO WKH DJH
REVHUYHG DPRQJ ZRPHQ DQG WKRWH
VWXG\ DUHD LV \SHU HQGHPLF ZLWK
ORVW PDODULD BRQJHPHQW DQG
RQ XQG HU KLOGUHQ DQG SUHJQDQV
PDGH WKH ROGHU SRSXODWLRQV WR
JHQHUDOO\ FRQVLGHUHG DV VHULRXV
WUDQVPLVVLRQ WKURXJK WKH ELWH
ZKHUH SHRSOH LQ WKH ROGHU
SUHYHQWLRQ DV LV GRQH LQ
KJJK ,Q JHQHUDO WKHUHIRUH
DFFHVV RI PRVTLWR WR WKH
SRSXODWLRQV WR XIFWVSHRUVH
FRQWURO DQG WULFDWPHQWV
LQ PDODULD HQGHPLF DUHDV
WR WKH GLVHDSVH

\$V SHRSOH HQWHU ROG DJHVGLWV
ROG DJH EFRPHV GHFUHDVLQJO\
KHDOWK VMDWKRUDRQ RI FKDQJHV
PDNH WKHP YXOQHUDEOH WR
LQIHFWLRXV GLVHDSVH ,W LV
HYLGHQW LQ WKLV VWXG\ WKDW
PDODULD LQIHFWLRQV RU PRUH
VHYHU RXWFRPHV RI
UHODWHG DQG LQFUHDVLQJO\
UHODWHG DQG LQFUHDVLQJO\
UHODWHG DQG LQFUHDVLQJO\

FRPPXQLFDEOH GLVHVDVH SDWKRORJLHV FRXOG LQFUHDVH VXFVHFWLELWLW\ WF
VHYHUH LQIHFWLRQV LQFOXGLQJ PDODULD LW LV DOVR SRVVLEOH WKDW KLJK PD
SUHYDOHQFH DQG LQWHQVLW\ FRXOG PDNH RQH VXFVHFWLEOH WR QRQ
FRPPXQLFDEOH ~~GLVHVDVH~~\ RI WKHVH QRQ FRPPXQLFDEOH
GLVHVDVH LQ WURSLFDO HQGHPLF DUHDV LV ODUJHO\ XQNQRZQ > @ +RZHYHU L
LV NQRZQ WKDW PDODULD SDUDVLWH DFWLYLW\ LV DVVRFLDWHG ZLWK R[LGDW
VWUHV LQ WKH EORRG DQG RWKHU DVVRFLDWHG WLVVXHV)UHTXHQW H[SRVXUH
WKH SDUDVLWH ZLWKRXW FRWURO DQG LQFUHDVHG SDUDVLWH LQWHQVLW\ ZLO
WUDQVODWH WR R[LGDWLYH VWUHV ,QFUHDVHG R[LGDWLYH VWUHV RQ WKH
KDQG ~~WLUJD~~ ~~FRPPXQLFDEOH~~ ~~GLVHVDVH~~ SDWKRORJ\
RI QRQ FRPPXQLFDEOH GLVHVDVH E\ LQGXFHQJ D ORW RI PHWDEROLF
GLVWXUEDQFH DV D UHVXOW RI WKH DFWLYLWLHV RI UHDFWLYH R[\JHQ VSHFLHV
H LQFLGHQFH RI GLVHVDVH UHODWHG WR VXFK PHWDEROLF GLVWXUEDQFHV IRU
LQVWDQFH GLDEHWHV UHQDO GLVHVDVH FDQFHUV DUH ULVLQJ DQG DUH PRVW
GHSHQGHQW ,Q DGGLWLRQ LPPXQH UHVSRVH WR PDODULD LV DVVRFLDWHG ZLW
WKH UHOHODVH ~~FRPPXQLFDEOH~~ NLQH V WKDW DUH DVVRFLDWHG ZLWK WKH
FRPSURPLVH RI QRUPDO ERG\ PHWDEROLV WKDW FRXOG UHVXOW LQ QRQ
FRPPXQLFDEOH GLVHVDVH ~~FRPPXQLFDEOH~~ GLWLRQV > @