SIMWEEVIL/SIMABL
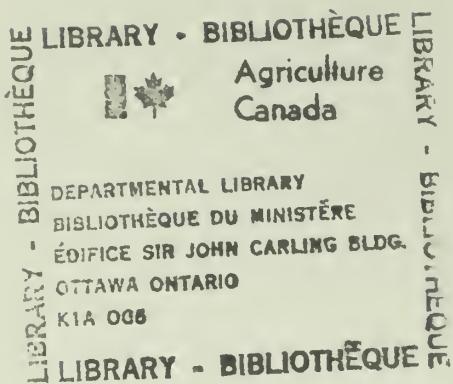
An IPM monitoring system for the alfalfa weevil and alfalfa blotch leafminer

Canada

SIMWEEVIL/SIMABL

An IPM monitoring system for the alfalfa weevil and alfalfa blotch leafminer

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          language March 1980
          VAX/VMS FORTRAN
          April 1980
Implementation: Agriculture Canada DEC
          VAX-11/780 System B
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      "A user's guide to SIMWEEVIL —
      A monitoring system for the alfalfa weevil"
Contents: 1. Description
          2. Data files and procedures
          3. Using SIMWEEVIL/SIMABL
          4. Information for the SIMWEEVIL/
            SIMABL manager
          5. Example session
          6. Program listings

Summary

This bulletin documents a computerized multipest-crop system
of alfalfa IPM in southern Ontario. Termed SIMWEEVIL/SIMABL, the
system monitors seasonal development of the alfalfa weevil and the
alfalfa blotch leafminer together with their host crop, and
automatically issues advisories that describe actions to be taken
by field scouts and/or growers. It is implemented through the
Agriculture Canada, VAX 11/780 computer and is available on-line
to agencies throughout Ontario.

Résumé

Le présent communiqué décrit un système informatisé de
lutte intégrée contre les parasites de la luzerne pour le Sud
de l'Ontario. Le système, appelé SIMWEEVIL/SIMABL, surveille
la croissance saisonnière des populations de charançons de la
luzerne et d'agromyzes de la luzerne ainsi que le développement
de leur plante hôte et émet automatiquement des avis aux agents
d'avertissement et aux agriculteurs en leur indiquant les
mesures à prendre. Ce système est mis en oeuvre grâce à
l'ordinateur VAX 11/780 du ministère de l'Agriculture du Canada
et tous les organismes de l'Ontario peuvent y accéder directement.

1. Description

SIMWEEVIL/SIMABL is a collection of data files and
procedures which were designed to monitor seasonal
development of the alfalfa weevil, Hypera postica (Gyll.),
and the alfalfa blotch leafminer, Agromyza frontella (Rond.),
together with their host crop. The system was developed for use
in alfalfa pest management and has particular reference
to crop and pest conditions in southern Ontario.
Seasonal development is calculated using the temperature-driven
polynomial growth algorithm of Harcourt and Yee (1982). For the
insects, the polynomial coefficients were derived from Guppy
and Mukerji (1974) and Guppy (1981). For the crop, they were
derived from heat unit requirements for each stage (Harcourt,
unpublished). Input data consist of daily maximum and minimum air
temperatures (Celsius) as well as long term values which
are filed and stored by location.
Temperatures may be entered at any time throughout
the field season beginning on 1 April and may be entered
on a daily or periodic basis, e.g. following a weekend.
In addition, 5-day forecast data may be used for predictive
purposes and then overwritten by actual values.
Historical data are used for missing entries; however,
the number of actual values should be maximized since no
year is really typical.

Output consists of the location name, a status
report and an advisory message. The status report is
composed of 4 items : (1) the date, (2) the alfalfa growth
stage and expected number of days until the next stage,

(3) the weevil life stage together with its cumulative
development within that stage and the expected number
of days until peak of the next, and (4) the alfalfa
blotch leafminer life stage together with its cumulative
development within that stage and the expected number
of days until peak of the next. The advisories
describe actions to be taken by a field scout and/or
grower.

SIMWEEVIL/SIMABL divides the life cycle of the
weevil into 7 stages : egg, instar 1, instar 2, instar3,
instar 4, cocoon (combined prepupal and pupal stages),
and adult. It divides the life cycle of the blotch leafminer
into 4 stages : adult, egg, larva and pupa.
It recognizes 7 stages of crop development : prebud,
early bud, mid bud, late bud, early bloom, late bloom,
and full flower; these stages correspond to those of James (1971).

SIMWEEVIL/SIMABL is an extension of the SIMWEEVIL
package (Yee and Harcourt (1982)). It monitors development
of the two pests throughout their active seasons. However,
alfalfa development is not monitored beyond full bloom of
the first crop since development of subsequent crops is
dictated by dates of harvest. The weevil advisories pertain
to the first crop of alfalfa and its early stages of regrowth.
The leafminer advisories pertain to alfalfa produced in
a three-cut system.

REFERENCES

Guppy, J. C. 1981. Bionomics of the Alfalfa Blotch Leafminer
Agromyza frontella (Diptera:Agromyzidae)
in Eastern Ontario.
Can. Entomol. 113:593-600

Guppy, J. C. & M. K. MukerJi. 1974. Effects of Temperature on
Develpomental Rate of the Immature Stages of
the Alfalfa Weevil, Hypera postica
(Coleoptera:Curculionidae).
Can. Entomol. 106:93-100

Harcourt, D. G. & J. M. Yee. 1982. Polynomial Algorithm for
Predicting the Duration of Insect Life Stages.
Environ. Entomol. 11:581-584

James, C. 1971. A manual of assessment keys for plant diseases.
Canada Dept. Agric. Publ. 1458.

Yee, J. M. & D. G. Harcourt. 1982. A user's guide to SIMWEEVIL
A monitoring system for the alfalfa weevil.
Ottawa Research Station, Agriculture Canada
Ministry of Supply and Services.

2. Data Files and Procedures

2.1 Data Files - direct access, relative

These files contain "local" data, that is, data which
are specific to a location such as temperature. In the
following descriptions the symbol 'LOCATION' represents
a place holder for the actual location name, for
example OTTAWAS.DAT

'LOCATION'S.DAT   record 1   addresses of alfalfa,

                                       weevil and blotch leafminer

                                       data blocks, and end-of-file

               r = address of a data block

               record r current life stage (CLS)

                                         number, CLS name,

                                         cumulative development

                                         units (CDU), last date of

                                         processing, predicted days

                                         to next stage

               record $r+k$ life stage k, date of

                                         predicted peak, date of

                                         observed peak

'LOCATION'T.DAT   record 1   daily maximum temperatures

                      record 2   daily minimum temperatures

2.2 Procedures

SIMWEEVIL.COM   command procedure which supervises the

                         execution of the SIMWEEVIL/SIMABL programs

READSITE.COM   prompts for location to be analyzed,

                         searches for location in its internal list,

                         if location is new the user is so informed

                         and the no-process condition is set

ENTERDATA.EXE   Prompts for temperature data, stores
                 data in 'LOCATION'T.DAT

DEVELOP.EXE   fetches temperature and life stage data,
                 executes development algorithm, predicts
                 number of days to next life stage,
                 stores updated life stage variables in
                 'LOCATION'S.DAT

REPORT.EXE   reports the alfalfa, weevil and blotch
                 leafminer life stage at the location
                 being analyzed up to midnight of the
                 present day, prints advisory

3. Using SIMWEEVIL/SIMABL

   3.1 User execution

      1. log-on to Agriculture Canada VAX system B

      2. wait for the command prompt $

      3. start the command procedure SIMWEEVIL by typing
        . the appropriate string

         a. Ottawa Res. Stn. - @SIMWEEVIL (RETURN)

         b. OMAF   - WEEVIL (RETURN)

         c. others   - @[AG338000]SIMWEEVIL (RETURN)

         Note : The location name may be inserted after
                SIMWEEVIL or WEEVIL and before RETURN

      4. answer the prompts (see 3.2.2)

      5. logoff

   3.2 Details on data input

   3.2.1 The location parameter is an optional character string
         naming the location to be analyzed. If the string is
         omitted, the command procedure READSITE will prompt
         for it. Location names must not contain embedded

blanks and should not be longer than 8 alphanumeric

characters. Longer names will be truncated to the

first 8 characters.

example : $@SIMWEEVIL OTTAWA (RETURN)

3.2.2 The prompts indicate the type of input data

required (character or numeric). Responses must

correspond to the data type. Spaces should be

avoided except where necessary. Dates are entered

as a 4 digit integer (MMDD); e.g. May 4 == 504

Prompts and appropriate responses :

a. prompt   : YOUR LOCATION?

   response : name of location

b. prompt   : ENTER Y(ES) IF YOU HAVE YESTERDAY'S TEMPS.

   response : Y   for yes
              RETURN or any other character for no

c. prompt   : ENTER MAX AND MIN TEMP.

   response : max and min in C, separate values

              with a space or comma

d. prompt   : ENTER Y(ES) IF YOU HAVE OTHER DAY'S TEMPS.

   response : as in b.

e. prompt   : DATE-MONTH DAY

   response : 4 digit integer representing month

              and day, e.g. April 7 is entered 407

              if there are nomore data to be entered

              type a RETURN

f. prompt   : ENTER Y[ES] FOR ANOTHER LOCATION

   response : Y or T for another location,

              type a RETURN for system exit

Input errors will usually result in an error message
and a reprompt. The number of error/reprompt cycles
is limited to prevent an infinite loop. Any system
error messages should be reported to the SIMWEEVIL/SIMABL
manager as these may result from program "bugs".
Such bugs may cause misinformation to be written to
the data files.

Avoid running SIMWEEVIL before temperature data have
been gathered. Entering past data after a run may
introduce errors in the predicted date of the peak
of a life stage.

The status report should start printing within 10
seconds after the last temperature prompt has been
answered.

4. Information for the SIMWEEVIL/SIMABL Manager

   4.1 Procedure files

      a. SIMWEEVIL.COM is placed in the HOME directory of
         the Ottawa Research Station account

      b. All other procedures should be placed in the
         subdirectory [.S.SIMWEEV] . If they are placed
         in another subdirectory the global variable
         DIRECT in SIMWEEVIL.COM must be reassigned
         accordingly.

      c. DEVELOP, ENTERDATA, REPORT must be compiled and
         and linked. The .OBJ files should be deleted to
         save space. REPORT must be compiled with the
         qualifier /CONTINUATIONS=99

4.2 Data files

All data files must be placed in the same subdirectory
as indicated in 4.1b. The file protection code must
be set so that WORLD is at least RW ; otherwise,
non-AG3380000 users cannot update (write to) the
data files. The program UTIL will convert editor
constructed (sequential) files into relative, direct
access files used by the SIMWEEVIL/SIMABL programs.

a. 'LOCATION'T.DAT   recl=(number of days in season)+1

  editor file format : all records 2F6.1

  contents : each record contains a max/min temp.

  The LOCATION'T.DAT file for a site is created by
  WRITEing the editor file to the file 'LOCATION'T
  using the program UTIL and UTILITY code 1.

b. 'LOCATION'S.DAT   recl=6

  editor file format : rec   1   3I3

                       rec   2   I3,A16,F6.4,2I3

                       rec   3<=k<=10 A16,2I5

                       rec 11   as rec 2

                       rec 12<=k<=21 as recs 3-10

                       rec 22   as rec 2

                       rec 23<=k<=57 as recs 3-10

  The 'LOCATION'S.DAT files for the different sites
  are initialized by WRITEing the file LOC to the
  file 'LOCATION'S using the program UTIL and code 2.
  If the season start is not April 1 then change
  401 to the appropriate date and change 91 to

(Julian date of season start)-1. For example, if

Ottawa season start is April 21 then 401 becomes

421 and 91 becomes 111 in the OTTAWAS.DAT file.

The ABL adult emergence stage logically belongs in the

same generation as the pupa generation, and the programs

follow this convention. For purposes of reporting

advisories the adult emergence stage is incorporated

into the next generation.

```
column
1234567890123456789012345678901234S

  2 11 22 58
  1          PRE BUD0.0000 91 10
           PRE BUD  401      0
         EARLY BUD    0      0
           MID BUD    0      0
          LATE BUD    0      0
       EARLY BLOOM    0      0
        LATE BLOOM    0      0
       FULL FLOWER    0      0
     NOTHING ELSE 1231 1231
  1              EGG0.0000 91 10
               EGG  401      0
             HATCH    0      0
   LARVAL INSTAR 1    0      0
   LARVAL INSTAR 2    0      0
   LARVAL INSTAR 3    0      0
   LARVAL INSTAR 4    0      0
            COCOON    0      0
   ADULT EMERGENCE    0      0
             ADULT    0      0
          NO OTHER 1231 1231
  6         PUPA G0-.4000 91 10
         ADULT G0    0      0
           EGG G0    0      0
         HATCH G0    0      0
         LARVA G0    0      0
    LARVA DROP G0    0      0
          PUPA G0  401      0
   ADULT EMERG. G1    0      0
         ADULT G1    0      0
           EGG G1    0      0
         HATCH G1    0      0
         LARVA G1    0      0
    LARVA DROP G1    0      0
          PUPA G1    0      0
   ADULT EMERG. G2    0      0
         ADULT G2    0      0
           EGG G2    0      0
         HATCH G2    0      0
         LARVA G2    0      0
    LARVA DROP G2    0      0
          PUPA G2    0      0
   ADULT EMERG. G3    0      0
         ADULT G3    0      0
           EGG G3    0      0
         HATCH G3    0      0
         LARVA G3    0      0
    LARVA DROP G3    0      0
          PUPA G3    0      0
   ADULT EMERG. G4    0      0
         ADULT G4    0      0
           EGG G4    0      0
         HATCH G4    0      0
         LARVA G4    0      0
    LARVA DROP G4    0      0
          PUPA G4    0      0
          NO OTHER 1231 1231
```

SIMWEEVIL/SIMABL is currently set up to process the
locations Guelph, Ottawa, Simcoe, Smithfield, Kemptville
and a dummy location TEST. If a new location, call it
Newsite, is to be processed then READSITE.COM must
be modified and two data files, NEWSITET.DAT and
NEWSITES.DAT, must be created.

READSITE is modified by adding the line
$LOC7:=NEWSITE and by changing the line $LOCLIM=6 to
$LOCLIM=7 . Both of these lines are located at the
beginning of the program (see section 6).

NEWSITET.DAT is created in two steps. Step 1 is
to use the editor to create a sequential file of daily
temperatures. Each record contains one max/min pair
and there must be one record for each day of the season.
The temperatures entered are arbitrary; however, since
they are used for development predictions historical
temperatures are recommended. For instance, 10-year
normals or the previous year's observations may be
employed. Step 2 is to use the program UTIL to write
the sequential file to the relative file NEWSITET .
NEWSITET.DAT must not exist already. The old sequential
file may be deleted to save space.

NEWSITES.DAT is created by using UTIL to write the
sequential file LOC to NEWSITES . If the season start
for Newsite is not April 1, then LOC must be changed
before using UTIL (see 4.2b). NEWSITES.DAT must not
exist already.

4.4 Extending the SIMWEEVIL/SIMABL season

The SIMWEEVIL/SIMABL season may be extended beyond September
30 by changing the parameter values in the programs
shown in the following table.

Extending the SIMWEEVIL/SIMABL Season

Program	Parameter(s)	Location of Parameter(s)
DEVELOP	LAST	MAIN
		subroutine ACCUMULATE
ENTERDATA	FINISH	MAIN
	LAST	MAIN
		subroutine INDATA
REPORT	FINISH	MAIN
UTIL	LAST	MAIN

The parameter FINISH is the date of the end of the
season expressed as a 4 digit integer (MMDD),
e.g. for October 31, FINISH =1031 . The parameter LAST
is the Julian date (366 day year) of the end of the
season, e.g. for October 31, LAST = 305 .
Make sure the 'LOCATION'S files contain enough life stages
to accomodate the longer season. If more stages are added,
the addresses (record 1) must be corrected. In addition
program REPORT, subroutine ADVISE must be revised to
accomodate the additional stages.

. Example Session

The following session was conducted on the Ottawa Research
Station account. The blank line after the prompt for
YESTERDAY'S TEMPS. is really a carriage return indicating
a negative (NO) response. Similarly the blank line after
the third DATE-MONTH DAY prompt is a carriage return indicating
no more data are to be entered. As shown by the time stamps
at the beginning and end of the session, the entire
process took less than three minutes.

```
enter class 21
class 021 start
```
```
Username: AG3380000
Password:
        Welcome to VAX/VMS Version V2.5 on node _OTTB::


  29-MAY-1982 14:41:36

  User [024,002] has 5741 blocks used, 259 available,
  of 6000 authorized and permitted overdraft of 100 blocks on USER1

$ @SIMWEEVIL TEST
 ENTER Y(ES) IF YOU HAVE YESTERDAY'S  TEMPS.

 ENTER Y(ES) IF YOU HAVE OTHER DAY'S  TEMPS.
Y
 DATE-MONTH DAY
527
ENTER MAX AND MIN TEMP.
22.5,10.0
 DATE-MONTH DAY


LOCATION : TEST
STATUS AS OF 00:00H 29-MAY-82




ALFALFA CROP STAGE :          EARLY BUD
                              MID BUD EXPECTED WITHIN  4 DAYS.
MAXIMUM PROTEIN LEVELS HAVE BEEN REACHED.




ALFALFA WEEVIL STAGE :  LARVAL INSTAR 1 ; DEVELOPMENT=   2 %
                    LARVAL INSTAR 2 PEAK EXPECTED WITHIN  4 DAYS.
CHECK FOR LARVAL FEEDING DAMAGE IN FOLIAGE. IF 25% OF STEMS
SHOW FEEDING DAMAGE IN THE TIPS, HARVEST OR SPRAY IMMEDIATELY.




ALFALFA B. L.  STAGE :          ADULT G1
                              EGG G1 PEAK EXPECTED WITHIN  3 DAYS.
PINHOLING WILL BE EVIDENT IN AREAS OF HIGH INFESTATION.
                STARTING IN  1 DAYS
USE EARLY WARNING SYSTEM TO ARRIVE AT A TREAT/NOTREAT DECISION.
IF NOTREATMENT INDICATED, RESAMPLE IN 3 OR 4 DAYS. IF TREATMENT
INDICATED, HARVEST IMMEDIATELY IF CROP HAS REACHED BUD STAGE
AND THERE IS SUFFICIENT BULK. OTHERWISE SPRAY WITH A PESTICIDE.


ENTER Y[ES] FOR ANOTHER LOCATION.
END OF SIMWEEVIL.
$ LOGOFF
  AG3380000      logged out at 29-MAY-1982 14:44:23.07
```

SIMWEEVIL/SIMABL Programs

    6.1 SIMWEEVIL.COM

    6.2 READSITE.COM

    6.3 ENTERDATA.FOR

    6.4 DEVELOP.FOR

    6.5 REPORT.FOR

Utility Program

    6.6 UTIL.FOR

```
100   $:  6.1  SIMWEEVIL.COM
200   $:COMMAND PROCEDURE FOR ALFALFA WEEVIL DEVELOPMENT
300   $:
500   $:!INITIALIZE
600   $ ON ERROR THEN GOTO L
700   $ DIRECT:==[AG33B0000.S.SIMWEEV]
800   $ TFIL:=="      ;GLOBAL VARIABLES. REASSIGNED IN READSITE
900   $ SFIL:==""
1000  $:
1100  $:L:
1200  $:
1300  $ ASSIGN/USER SYSSCOMMAND FOR005
1400  $ !DIRECT'READSITE 'P1' 'P2' 'P3' 'P4' 'P5' 'P6' 'P7' 'P8'
1600  $ IF SFIL .EQS. IFIL THEN GOTO AGAIN
1700  $:
1800  $ ASSIGN/USER SYSSCOMMAND FOR005
1900  $ ASSIGN/USER 'DIRECT''IFIL' TMP
2000  $ ASSIGN/USER 'DIRECT''SFIL' LFSTG
2100  $ RUN 'DIRECT'ENTERDATA
2200  $:
2300  $ ASSIGN/USER 'DIRECT''TFIL' TMP
2400  $ ASSIGN/USER 'DIRECT''SFIL' LFSTG
2500  $ RUN 'DIRECT'DEVELOP
2600  $:
2700  $ WRITE SYSSOUTPUT "LOCATION : ''LOCATION'"
2800  $:
2900  $ ASSIGN/USER 'DIRECT''SFIL' LFSTG
3000  $ RUN 'DIRECT'REPORT
3100  $:
3200  $AGAIN:
3300  $ !RESETS COMMAND PROCEDURE PARAMETERS.
3400  $ P1:==
3500  $ P2:==
3600  $ P3:==
3700  $ P4:==
3800  $ P5:==
3900  $ P6:==
4000  $ P7:==
4100  $ P8:==
4200  $:  PROMPTS FOR ANOTHER SITE. IF NONE THEN EXIT SIMWEEVIL
4300  $ INQUIRE/NOPUNC ANOTHER "ENTER Y[ES] FOR ANOTHER LOCATION."
4400  $ IF ANOTHER .EQS. "Y" THEN GOTO L
4500  $ WRITE SYSSOUTPUT "END OF SIMWEEVIL."
4600  $:!END OF SIMWEEVIL COMMAND PROCEDURE
```

```
100   $!  6.2  READSITE.COM
200   $! COMMAND PROCEDURE TO READ SITE NAME. IF SITE IS NEW, THEN USER
300   $! IS INFORMED THE SITE IS NOT IN THE EXTENSION PROGRAM.
400   $!
500   $! LOCATIONS ON LINE
600   $ LOC1:==SIMCOE
700   $ LOC2:==SMITHFIE
800   $ LOC3:==GUELPH
900   $ LOC3:==GUELPH
1000  $ LOC4:==OTTAWA
1100  $ LOC5:==KEMPTVIL
1200  $ LOC6:==TEST
1300  $ LOCLIM=6
1400  $ K=0
1500  $! MERGE EMBEDDED BLANKS IN LOCATION NAME (IF PASSED AS PARAMETERS)
1600  $ SITE:=='P1''P2''P3''P4''P5''P6''P7''P8'
1700  $ IF SITE .EQS. " " THEN GOTO RL0
1800  $ GOTO RL1
1900  $ RL0:
2000  $ INQUIRE/NOPUNC SITE "YOUR LOCATION? "
2100  $ IF SITE .EQS. "" THEN GOTO RLW
2200  $ LEN=='F$LENGTH(SITE)
2300  $ LOC=='F$LOCATE(" ",SITE)
2400  $ IF LOC .GE. LEN THEN GOTO RL1
2500  $ RLW:
2600  $ WRITE SYS$OUTPUT "LOCATION MUST BE ONE WORD."
2700  $ K=K+1
2800  $ IF K .LE. 5 THEN GOTO RL0
2900  $ WRITE SYS$OUTPUT "ERROR LIMIT EXCEEDED. PROCEDURE EXIT."
3000  $ EXIT
3100  $ RL1:
3200  $! TRUNCATE LOCATION NAME TO 8 CHARACTERS
3300  $ LEN=='F$LENGTH(SITE)
3400  $ IF LEN .GT. 8 THEN LEN=8
3500  $ LOCATION:=='F$EXTRACT(0,LEN,SITE)
3600  $ C=1
3700  $ SITELOOP:
3800  $! SEARCH FOR SITE NAME IN INTERNAL LIST
3900  $ IF LOCATION .EQS. LOC'C' THEN GOTO OK2
4000  $ C=C+1
4100  $ IF C .LE. LOCLIM THEN GOTO SITELOOP
4200  $ NEWSITE:
4300  $ WRITE SYS$OUTPUT " "
4400  $ WRITE SYS$OUTPUT "YOUR LOCATION IS NEW AND THUS IS NOT INCLUDED"
4500  $ WRITE SYS$OUTPUT "IN THE WEEVIL/ABL MONITORING PROGRAM. CALL THE"
4600  $ WRITE SYS$OUTPUT "MONITORING PROGRAM AL 613-996-7676 AND ASK"
4700  $ WRITE SYS$OUTPUT "FOR THE SIMWEEVIL/SIMABL MANAGER."
4800  $ WRITE SYS$OUTPUT " "
4900  $ TFIL:==NEWLOCATION
5000  $ SFIL:==NEWLOCATION
5100  $ GOTO ENDLABEL
5200  $ OK2:
5300  $ TFIL:=='LOCATION'T.DAT;1
5400  $ SFIL:=='LOCATION'S.DAT;1
5500  $ ENDLABEL:
5600  $! END OF READSITE COMMAND PROCEDURE
```

```
100   C        6.3    ENTERDATA.FOR
200   C
300   C        PROGRAM ENTERDATA
400   C
500   C        THIS PROGRAM ACCEPTS TEMPERATURE DATA FROM THE
600   C        TERMINAL. THE DATA ARE ENTERED INTO THE
700   C        TEMPERATURE FILE OF THE CURRENT LOCATION.
800   C
900   C
1000  C        LOGICAL FUNCTION PROMPT(PMT)
1100  C        INQUIRES WHETHER OR NOT USER HAS TEMPERATURE DATA TO ENTER
1200  C        RETURNS LOGICAL TRUE IF USER HAS DATA TO ENTER,
1300  C        OTHERWISE RETURNS LOGICAL FALSE    PMT
1400           CHARACTER*(*) PMT
1500           INTEGER K
1600           CHARACTER ANS*1
1700  C
1800   100     K=0
1900           WRITE(6,*) ' ENTER Y(ES) IF YOU HAVE',PMT,' TEMPS.'
2000           READ(5,501,ERR=200) ANS
2100   501     FORMAT(A1)
2200           GOTO 300
2300   200     WRITE(6,*) ' ERROR.'
2400           K=K+1
2500           IF (K .LE. 4) GOTO 100
2600           WRITE(6,*) ' ERROR LIMIT EXCEEDED. NOMORE DATA ASSUMED.'
2700   300     PROMPT=ANS.EQ.'Y'
2800           RETURN
2900           END
3000  C        END OF LOGICAL FUNCTION PROMPT
3100  C
3200  C
3300  C        SUBROUTINE RESET(START,FINISH,MINDAY,NORGS,ORGOFF)
3400  C        RESETS LIFE STAGE VARIABLES IF TEMPERATURE DATA FOR A DAY (MINDAY)
3500  C        PREVIOUS TO LAST ACCESS DATE ( MRD ) ARE ENTERED. RESET AS
3600  C        FOLLOWS : 1.  CSTG = LIFESTAGE IN PROGRESS ON MINDAY
3700  C                  2.  CDU  = 0
3800  C                  3.  DAY  = DAY ON WHICH CSTG STARTED DEVELOPMENT
3900  C
4000           INTEGER MINDAY,PD,OBS,CLS,NXD,DAY,I,MONTH(1:12),DTOM(1:366)
4100           INTEGER START,FINISH,ORG,NORGS,ORGOFF(1:*)
4200           REAL CDU
4300           CHARACTER CSTG*16
4400           COMMON /CAL/DTOM,MONTH
4500  C
4600           DO ORG=1,NORGS
4700           CLS=0
4800  C        SEARCH FOR LAST STAGE WHICH COMPLETES DEVELOPMENT
4900  C        BEFORE MINDAY (INCLUSIVE)
5000   100     CLS=CLS+1
5100           READ(12,REC=CLS+ORGOFF(ORG)) CSTG,NXD,OBS
5200           NXD=MAX(START,MIN(FINISH,NXD))
5300           I=NXD/100
5400           DAY=MONTH(I)+NXD-100*I
5500           IF (DAY .LT. MINDAY) GOTO 100
5600           CLS=MAX(1,CLS-1)
5700  C
5800  C        ABL PUPAE OVERWINTER, SO SPRING (INITIAL) STAGE
5900  C        IS PUPA, THUS MINIMUM CLS FOR ABL IS 6
6000  C        IF (ORG .EQ. 3) CLS=MAX(6,CLS)
6100
```

```fortran
6200 C
6300       READ(12,REC=CLS+ORGOFF(ORG)) CSTG,PD,ORS
6400       PD=MAX(START,MIN(FINISH,PD))
6500       I=PD/100
6600       DAY=MONTH(I)+PD-100*I-1
6700       CDU=0.0
6800 C
6900 C  ABL OVERWINTERING PUPAE GIVEN NEGATIVE DEVELOPMENT AS
7000 C  OF STARTING DATE. THIS SIMULATES A PRE SPRING ADJUSTMENT.
7100       IF ((ORG .EQ. 3) .AND. (CLS .EQ. 6)) CDU=-0.4
7200 C
7300       WRITE(12,REC=ORGOFF(ORG)) CLS,CSTG,CDU,DAY,10
7400 C
7500       END DO
7600 C
7700       RETURN
7800       END
7900 C
8000 C  SUBROUTINE INDATA(DAYS)
8100 C  PROMPTS FOR MAX AND MIN TEMPERATURE DATA,
8200 C  SAVES DATA IN TEMPERATURE VECTORS
8300       INTEGER FIRST,LAST
8400       PARAMETER (FIRST=92,LAST=274)
8500 C
8600       INTEGER DAYS,ERRCOUNT,RR,SOFF
8700       INTEGER MONTH(1:12),DIUM(1:366)
8800       REAL MX,MN,MAXT(FIRST:LAST),MINT(FIRST:LAST),R
8900       COMMON /CAL/DIUM,MONTH /TEMPBLK/MAXT,MINT
9000 C
9100       ERRCOUNT=0
9200       WRITE(6,*) 'ENTER MAX AND MIN TEMP.'
9300 100   READ(5,*,ERR=200) MX,MN
9400       GOTO 300
9500 C
9600 200   WRITE(6,*) ' ERROR. TEMPS MUST APPEAR AS 2 DECIMALS.'
9700       ERRCOUNT=ERRCOUNT+1
9800       IF (ERRCOUNT .GT. 4) GOTO 500
9900       GOTO 100
10000 C
10100 C  STORE DATA
10200 300   MAXT(DAYS)=MX
10300       MINT(DAYS)=MN
10400       RETURN
10500 500   WRITE(6,*) ' ERROR LIMIT EXCEEDED. DATA INPUT HALTED.'
10600       RETURN
10700       END
10800 C  END OF SUBROUTINE INDATA
10900 C
11000 C
11100 C  HOST ROUTINE
11200 C
11300       INTEGER FIRST,LAST,START,FINISH
11400       PARAMETER (FIRST=92,LAST=274,START=401,FINISH=930,NORGS=3)
11500       INTEGER ERRCOUNT,DD,MM,YY,MD,DAYS,MINDAY,MKD
11600       INTEGER MONTH(1:12),DIUM(1:366),ORGOFF(1:NORGS+1)
11700       LOGICAL MORE,OK,TDATA,PRUMP1
11800       CHARACTER ANS*1,C1*16
11900       REAL R1,MAXT(FIRST:LAST),MINT(FIRST:LAST)
12000       DATA MONTH/0,31,60,91,121,182,213,244,274,305,335/
12100       DATA DIUM/31*1,29*2,31*3,30*4,31*5,30*6,31*7,31*8,
12200              30*9,31*10,30*11,31*12/
```

```
12300  C       COMMON /CAL/DTOM,MONTH /TEMPBLK/MAXT,MINT
12400  C
12500  C       OPEN TEMPERATURE FILE
12600          OPEN(11,FILE='TEMP',STATUS='OLD',ACCESS='DIRECT')
12700          READ(11,1) (MAXT(I),I=FIRST,LAST)
12800          READ(11,2) (MINT(I),I=FIRST,LAST)
12900  C
13000          MINDAY=367
13100  C
13200  C       PROMPT FOR YESTERDAY'S TEMPERATURES
13300          TDATA=PROMPT('YESTERDAY''S')
13400          IF (TDATA) THEN
13500             CALL IDATE(MM,DD,YY)
13600             DAYS=MONTH(MM)+DD-1
13700             CALL INDATA(DAYS)
13800          END IF
13900  C
14000  C       PROMPT FOR OTHER DAYS' TEMPERATURES
14100          TDATA=PROMPT('OTHER DAY''S')
14200          IF (TDATA) THEN
14300             MORE=.TRUE.
14400             ERRCOUNT=0
14500             DO WHILE (MORE)
14600                WRITE(6,*)    ' DATE-MONTH DAY'
14700                READ(5,501,ERR=200) MD
14800  501           FORMAT(I6,I6)
14900                IF ((MD.GT.FINISH).OR.((MD.GT.0).AND.(MD.LE.99)))
15000  1                GOTO 200
15100                IF ((MD.LE.FINISH).AND.(MD.GE.START)) THEN
15200                   I=MD/100
15300                   DAYS=MONTH(I)+MD-100*I
15400                   MINDAY=MIN(MINDAY,DAYS)
15500                   CALL INDATA(DAYS)
15600                   ERRCOUNT=0
15700                ELSE
15800                   MORE=.FALSE.
15900                END IF
16000                GOTO 300
16100  200          WRITE(6,*)   'ERROR. DATE MUST BE A 4 DIGIT INTEGER.'
16200                ERRCOUNT=ERRCOUNT+1
16300                IF (ERRCOUNT.LE.4) GOTO 300
16400                WRITE(6,*)   'ERROR LIMIT EXCEEDED. INPUT STOP.'
16500                MORE=.FALSE.
16600  300          CONTINUE
16700             END DO
16800          END IF
16900  C
17000  C       SAVE TEMPERATURE DATA
17100          WRITE(11,1) (MAXT(I),I=FIRST,LAST)
17200          WRITE(11,2) (MINT(I),I=FIRST,LAST)
17300          CLOSE(UNIT=11,STATUS='KEEP')
17400  C
17500          OPEN(12,FILE='LFSTG',STATUS='OLD',ACCESS='DIRECT')
17600          READ(12,1) (ORGOFF(I),I=1,NORGS)
17700          READ(12,REC=ORGOFF(1)) DD,C1,R1,MRD,MM
17800          IF (MINDAY.LT.MRD) CALL RESET(START,FINISH,MINDAY,NORGS,ORGOFF)
17900          CLOSE(12,STATUS='KEEP')
18000  C
18100          STOP ' '
18200          END
18300  C       END OF PROGRAM ENTERDATA
```

```
6.4    DEVELOP.FOR

C      PROGRAM DEVELOP
C      THIS PROGRAM COMPUTES THE DEVELOPMENT OF THE CURRENT
C      ORGANISM USING A TEMPERATURE DRIVEN GROWTH ALGORITHM.
C      HARCOURT & YEE "POLYNOMIAL ALGORITHM FOR PREDICTING THE
C           DURATION OF INSECT LIFE STAGES"
C           ENVIRON. ENTOMOL. 11:581-4 1982

C      REAL FUNCTION RATE(A,M,T)
C      CUBIC POLYNOMIAL DEVELOPMENT FUNCTION. DEVELOPMENT
C      RATE IS A FUNCTION OF TEMPERATURE.
C      A = AMPLITUDE OF TEMPERATURE FUNCTION
C      M = MEAN TEMPERATURE
C      T = TIME OF DAY ( HRS )

       REAL    A,M,T,CF(0:3),CMAT(1:23,0:5),SLOPE,TMIN,R,TT,TEMP
       INTEGER I
       COMMON  /POLYBLK/CMAT,CF,SLOPE,TMIN

C      SKEWS TEMPERATURE CURVE SO MINIMUM OCCURS AT 0600
C      AND MAXIMUM OCCURS AT 1500
       TT=T
       IF (T .GT. 6)  TT=(1.333333*T)-2.0
       IF (T .GT. 15) TT=(0.6666667*T)+8.0

       TEMP=M-A*SIN(0.261799*TT)
       IF (TEMP .LT. 0.0) TEMP=0.0
       IF (TEMP .GT. TMIN) THEN
         R=CF(0)+TEMP*(CF(1)+TEMP*(CF(2)+TEMP*CF(3)))
       ELSE R=SLOPE*TEMP
       END IF

       IF (R .LT. 0.0) R=0.0
       RATE=R
       RETURN
       END
C      END OF FUNTION RATE

       SUBROUTINE ACCUMULATE(DAYLIM,MRD,STG,ORG)
C      ACCUMULATES DEVELOPMENTAL UNITS ( DU's )
C      DU IN 1 DAY = TIME INTEGRAL OF GROWTH RATE FUNCTION OVER 1 DAY

       INTEGER FIRST,LAST
       PARAMETER (FIRST=92,LAST=274)

       INTEGER DAYLIM,MRD,ORG
       INTEGER I,J,DAYS,CLS,MM,DD,MD,PRED,OBS,ISTG,SOFF
       2       MONTH(1:12),BTOM(1:23),ORGOFF(1:3),POLYOFF(1:3)
       REAL    COEF(0:3),CMAT(1:23,0:5),MINTEMP(FIRST:LAST),
       1       MAXTEMP(FIRST:LAST),CDU,f,SLOPE,TMIN,H,A,M
       CHARACTER*16 STG
       COMMON /LSPARM/CLS,CDU /TEMPBLK/MINTEMP,MAXTEMP
       COMMON /POLYBLK/CMAT,COEF,SLOPE,TMIN /CAL/DTOM,MONTH
       COMMON /OFFSET/SOFF,ORGOFF,POLYOFF

C      H=SUMMATION STEP SIZE IN HOURS
       H=3.0
```

```fortran
6200        DAYS=MRD+1
6300        DO WHILE (DAYS.LE.DAYLIM)
6400          A=(MAXTEMP(DAYS)-MINTEMP(DAYS))*0.5
6500          M=MINTEMP(DAYS)+A
6600          T=0.0
6700          DO WHILE (T.LT.24.0)
6800            CDU=CDU+H*(RATE(A,M,T)+4*RATE(A,M,T+H/2.0)+
6900      1                RATE(A,M,T+H))/144.0
7000            T=T+H
7100            IF (CDU.GE. 1.0) THEN
7200              CLS=CLS+1
7300              CDU=0.0
7400              ISTG=CLS+POLYOFF(ORG)
7500              IF (ORG.EQ.3) THEN
7600                K=MOD(CLS,7)
7700                IF (K.EQ.6) K=7
7800                ISTG=K+POLYOFF(ORG)
7900              END IF
8000              DO I=0,3
8100                COEF(I)=CMAT(ISTG,I)
8200              END DO
8300              SLOPE=CMAT(ISTG,4)
8400              TMIN=CMAT(ISTG,5)
8500              I=DAYS
8600              IF (T.GT. 15.0) I=DAYS+1
8700              MM=DTOM(I)
8800              DD=I-MONTH(MM)
8900              MD=100*MM+DD
9000              J=CLS+ORGOFF(ORG)
9100              READ(12,REC=J,ERR=100) STG,PRED,OBS
9200              WRITE(12,REC=CLS+ORGOFF(ORG)) STG,MD,OBS
9300            END IF
9400          END DO
9500          DAYS=DAYS+1
9600        END DO
9700  100   RETURN
9800        END
9900        END OF SUBROUTINE ACCUMULATE
10000       INTEGER FIRST,LAST
10100       PARAMETER (FIRST=92,LAST=274,NORGS=3)
10200       INTEGER CLS,CCLS,MRD,YESTERDAY,NEXTDAY,MM,DD,YY,ISTG,SOFF,ORG
10300       INTEGER ORGOFF(1:NORGS),POLYOFF(1:NORGS),MONTH(1:12),DTOM(1:366)
10400       REAL  MINTEMP(FIRST:LAST),MAXTEMP(FIRST:LAST)
10500       REAL  MAXT,MINT,SLOPE,TMIN,CCDU,CDU,COEF(0:3),CMAT(1:23,0:5)
10600       CHARACTER*16 STG,CSTG
10700       DATA MONTH/0,31,60,91,121,152,182,213,244,274,305,335/
10800       DATA DTOM/31*1,29*2,31*3,30*4,31*5,30*6,31*7,31*8,
10900      1          30*9,31*10,30*11,31*12/
11000 C     DATA  ALFALFA
11100 C     COEFFICIENTS FROM ALFALFA HEAT UNIT DEVELOPMENT
11200 C     DATA FROM HARCOURT ( UNPUBLISHED )
11300 C     CMAT(J,*)  STAGE
11400 C          1  PRE BUD
11500 C          2  EARLY BUD
11600 C          3  MID BUD
11700 C          4  LATE BUD
11800 C          5  EARLY BLOOM
11900 C          6  LATE BLOOM
```

24.

```
C     CMAT 7     FULL FLOWER
      (CMAT( 1,I),I=0,5)/-0.0149521,0.0029903,0.0,0.0,0.5.0/
      (CMAT( 2,I),I=0,5)/-0.007575576,0.0151515,0.0,0.0,0.25.0/
      (CMAT( 3,I),I=0,5)/-0.007575576,0.0151515,0.0,0.0,0.25.0/
      (CMAT( 4,I),I=0,5)/-0.007575576,0.0151515,0.0,0.0,0.25.0/
      (CMAT( 5,I),I=0,5)/-0.007575576,0.0151515,0.0,0.0,0.25.0/
      (CMAT( 6,I),I=0,5)/0.002,0.0,0.0,0.0,0.5.0/
C
      DATA
C     WEEVIL
C     COEFFICIENTS FROM
C     HARCOURT & YEE "POLYNOMIAL ALGORITHM FOR PREDICTING THE
C                     DURATION OF INSECT LIFE STAGES"
C                     ENVIRON. ENTOMOL. 11:581-4 1982
C
C     CMAT(J,*) STAGE
C         8     EGG ( 50% OF TOTAL EGG-INSTAR 1 STAGE )
C         9     HATCH ( 50% OF TOTAL EGG-INSTAR 1 STAGE )
C        10     LARVAL INSTAR 1
C        11     LARVAL INSTAR 2
C        12     LARVAL INSTAR 3
C        13     LARVAL INSTAR 4
C        14     COCOON (83.333% OF TOTAL PUPA-ADULT STAGE )
C        15     ADULT EMERGENCE ( 16.667% OF TOTAL PUPA-ADULT STAGE )
C
      (CMAT( 8,I),I=0,5)/-0.052786,0.0058651,0.0030498,0.0,0.069.0/
      (CMAT( 9,I),I=0,5)/0.14588,-0.03076,0.0030498,0.0,-2.586E-5,
      (CMAT(10,I),I=0,5)/0.009976,0.0,0.07294,-0.01538,0.0015249,-1.293E-5,
      (CMAT(11,I),I=0,5)/-0.0005838,0.005996,-8.5058E-5,
     +2.8124E-5,0.00435.8,0/
      (CMAT(12,I),I=0,5)/-0.12049,-0.025729,0.0021796,-3.013E-5,
      (CMAT(13,I),I=0,5)/-0.13123,0.023465,-9.3071E-4,2.5595E-5,
      (CMAT(14,I),I=0,5)/0.00358,0.039503,0.0021484,-2.74E-5,
      (CMAT(15,I),I=0,5)/1.24942,0.19751,0.010742,-1.37E-4,
      (CMAT(16,I),I=0,5)/0.002,0.0,0.0,0.0,0.10.0/
C
      DATA
C     BLOTCH LEAFMINER
C     COEFFICIENTS FROM
C     J.C. GUPPY "BIONOMICS OF THE ALFALFA BLOTCH LEAFMINER
C                 AGROMYZA FRONTELLA"( DIPTERA : AGROMYZIDAE )
C                 IN EASTERN ONTARIO"
C                 CAN ENTOMOL 113:593-600 1981
C     AND OTTAWA 1981 FIELD DATA
C     CMAT(J,*) STAGE
C        17     ADULT
C        18     EGG ( TO 50% HATCH OF EGGS )
C        19     HATCH ( FROM 50% HATCH OF EGGS TO LARVA INSTAR 1 )
C        20     LARVA ( INCLUDES INSTARS 1 TO 3 )
C        21     LARVA DROP ( 85% OF TOTAL LARVA-PUPA STAGE )
C        22     PUPA ( 85% OF TOTAL PUPA-ADULT STAGE )
C        23     ADULT EMERGENCE (15% OF TOTAL PUPA-ADULT STAGE )
      (CMAT(17,I),I=0,5)/0.0,0.25,0.05550/
      (CMAT(18,I),I=0,5)/1.71646,-0.338647,0.0225556,-4.38581E-4,
      (CMAT(19,I),I=0,5)/1.26413,-0.231328,0.015246,-2.9554E-4,
     +0.011992,10.0/
```

```
4      (CMAT(20,I),I=0,5)/0.70831,-0.136075,0.008968,-0.17385E-03,
4      (CMAT(21,I),I=0,5)/0.007054,10.0/
5      (CMAT(22,I),I=0,5)/4.013777,-0.771093,-0.050820,-0.98513E-03,
5      (CMAT(22,I),I=0,5)/0.039976,10.0/
6      (CMAT(22,I),I=0,5)/0.254240,-0.0500297,0.00335937,-6.5754E-5,
6      (CMAT(23,I),I=0,5)/0.0024126,10.0/
7      (CMAT(23,I),I=0,5)/1.440699,-0.283502,0.0190365,-3.72607E-4,
       0.013672,16.07
C
       DATA SOFF/1/ POLYOFF/0,7,16/
       COMMON /LSPARM/CLS,CDU /POLYBLK/CMAT,COEF,SLOPE,TMIN
       COMMON /TEMPBLK/MINTEMP,MAXTEMP /CAL/DTOM,MONTH
       COMMON /OFFSET/SOFF,ORGOFF,POLYOFF
C
CC     OPEN FILES
       OPEN(UNIT=11,FILE='TMP',STATUS='OLD',ACCESS='DIRECT',READONLY)
       OPEN(UNIT=12,FILE='LFSTG',STATUS='OLD',ACCESS='DIRECT')
C
CC     INITIALIZE
C      TEMPERATURE
       READ(11'1) (MAXTEMP(I),I=FIRST,LAST)
       READ(11'2) (MINTEMP(I),I=FIRST,LAST)
C      ORGANISM LIFE STAGE DATA BLOCK ADDRESSES ( = OFFSETS+1 )
       READ(12'1) (ORGOFF(I),I=1,NORGS)
C      YESTERDAY IN DAYS
       CALL IDATE(MM,DD,YY)
D      READ(16,161) MM,DD,YY
D 161  FORMAT(3I2)
       YESTERDAY=MONTH(MM)+DD-1
C
CC     ORGANISM LOOP
       DO ORG=1,NORGS
C      LIFE STAGES
       READ(UNIT=12,REC=ORGOFF(ORG)) CLS,STG,CDU,MRD,I
C
CC     POLYNOMIAL COEFFICIENTS ETC.
       ISTG=CLS+POLYOFF(ORG)
C
CC     BLOTCH LEAFMINER GIVES A LITTLE PROBLEM. MULTIPLE GENERATIONS
CC     IMPLY LIFE STAGE DEVELOPMENT COEFFICIENTS CAN BE
CC     REUSED FROM GENERATION TO GENERATION.MOD FUNCTION ALLOWS
CC     "RECYCLING" OF COEFFICIENTS.OVERWINTERING PUPAE HAVE DIFFERENT
CC     COEFFICIENTS BECAUSE THEY COMPLETE DEVELOPMENT AT CDU = 1.4
CC     USING APRIL 1 START AND SUMMER PUPA COEFFICIENTS.
       IF (ORG.EQ.3) THEN
         I=MOD(CLS,7)
         IF(I.EQ.6) I=7
         ISTG=I+POLYOFF(ORG)
       END IF
       DO I=0,3
         COEF(I)=CMAT(ISTG,I)
       END DO
       SLOPE=CMAT(ISTG,4)
       TMIN=CMAT(ISTG,5)
C
CC     DEVELOPMENTAL THRESHOLD FOR ABL OVERWINTERED PUPAE
C      W.K.MELLORS,"A COMPUTER SIMULATION MODEL FOR THE ALFALFA
C      BLOTCH MINER" CORNELL UNIV.AGRIC.EXPER.STN.,NO.20,1981
       IF ((ORG.EQ.3).AND.(CLS.EQ.6)) THEN
         SLOPE=0.0
         TMIN=6.0
```

```
24500   C         END NOTE: MELLORS'S TMIN VALUE IS REALLY 5.6
24600             END IF
24700   C
24800   C         ACCUMULATE DEVELOPMENT UP TO TODAY
24900             CALL ACCUMULATE(YESTERDAY,MRD,STG,ORG)
25000             CCDU=CDU
25100             CCLS=CLS
25200             CSTG=STG
25300   C
25400   C         PREDICT DATE OF NEXT STAGE PEAK
25500             I=YESTERDAY+1
25600             DO WHILE ((CLS.LE.CCLS) .AND. (I .LE. LAST))
25700               CALL ACCUMULATE(I,I-1,STG,ORG)
25800               I=I+1
25900             END DO
26000             NEXTDAY=MAX(0,I-YESTERDAY-2)
26100             IF (CCLS.LE.CCLS) THEN
26200               READ(UNIT=12,REC=ORGOFF(ORG)+CCLS) STG,MM,DD
26300   C           PEAK DATE IN MM; LET DD=JULIAN DATE OF PEAK DATE
26400               DD=MONTH(MM/100)+MOD(MM,100)
26500               NEXTDAY=50
26600               IF (CDU.GT.0.0) NEXTDAY=((I-DD)/CDU)+DD-YESTERDAY-1
26700             END IF
26800   C
26900   C         STORE VARIABLES
27000             WRITE(UNIT=12,REC=ORGOFF(ORG)) CCLS,CSTG,CCDU,YESTERDAY,NEXTDAY
27100   C
27200   C         END OF ORGANISM LOOP
27300             END DO
27400   C
27500             CLOSE(UNIT=11,STATUS='KEEP')
27600             CLOSE(UNIT=12,STATUS='KEEP')
27700   C
27800             STOP ' '
27900             END
28000   C         END OF PROGRAM DEVELOP
```

```fortran
C     6.5   REPORT.FOR
C
C  PROGRAM REPORT
C  THIS PROGRAM PRINTS OUT THE STATUS OF THE ALFALFA CROP,
C  WEEVIL AND BLOTCH LEAFMINER AT THE CURRENT LOCATION.
C
C
C  SUBROUTINE ABLLUMP(STG,CDU,NSTG,CLS,ND,PERCENT)
C  LUMPS ABL STAGES TOGETHER FOR THE PRINTOUT.
C
C  HATCH INTO EGG STAGE
C  LARVA DROP INTO LARVA STAGE
C  ADULT EMERGENCE INTO PUPA STAGE
C
      CHARACTER*16 SIG,NSTG
      INTEGER      CLS,ND,PERCENT
      REAL         CDU
      CHARACTER*6  CSIG(1:7),CNSTG(1:7),G(0:4)*2
      INTEGER      F(K,GEN),SND(1:7)
      REAL         BASE(1:7),F(1:7)
      DATA CSTG/'ADULT ',' EGG  ',' PUPA ',   EGG ',  'LARVA ',
     2          'LARVA ',' PUPA ',
      DATA CNSTG/' EGG  ',' LARVA ', 'LARVA ',
     2           ' ADULT ',' PUPA ',
      DATA G/'G0',' G1','G2','G3','G4'/
C
C  SND - NUMBER OF DAYS TO ADD TO NEXTDAY ( ND ) IN ORDER TO
C        PREDICT TIME TO NEXT REPORTED STAGE.
C  E.G.  IF CURRENT STAGE = PUPA, REPORT MUST JUMP OVER
C        ADULT EMERGENCE STAGE TO ADULT STAGE. THUS
C        REPORT MUST ADD IN DURATION OF EMERGENCE-TO-ADULT
C        INTERVAL TO PREDICT TIME TO ADULT PEAK
C        INTERVAL OF CURRENT STAGE IN ITS CONTRIBUTION TO
C
C  F   -  WEIGHT OF CURRENT STAGE IN
C         LUMPED STAGE.
C  E.G.  IF CURRENT STAGE = HATCH F = 50% BECAUSE HATCH
C        FORMS 50% OF THE TOTAL EGG-LARVA INTERVAL ( WHICH
C        MAKES UP THE REPORTED EGG STAGE )
C
C  BASE -  PERCENT DEVELOPMENT WHICH MUST BE ADDED TO THE WEIGHTED
C          DEVELOPMENT OF THE CURRENT REPORTED STAGE TO GET PERCENT
C          DEVELOPMENT OF THE LUMPED REPORTED STAGE
C          STAGE UP TO THE CURRENT DEVELOPMENTAL STAGE
C          EQUIVALENTLY BASE = CUMULATIVE DEVELOPMENT OF LUMPED
C  E.G.  IF CURRENT STAGE = HATCH BASE = 50% BECAUSE
C        CUMULATIVE DEVELOPMENT OF REPORTED EGG STAGE = 50%,
C        TO THIS BASE MUST BE ADDED THE WEIGHTED HATCH
C        DEVELOPMENT ( BASE = 50% * HATCH CDU )
C
      DATA SND/0,4,65,6,3,0/  BASE/0,0,50,0,0,50,0,0,85,0/
     2     F/100,0,50,0,50,0,85,0,15,0/
C
      K=MOD(CLS,7)
      IF (K.EQ.0) K=7
      GEN=(CLS-K)/7
      STG=' '//CSTG(K)//G(GEN)
      IF (K.GE.6) GEN=GEN+1
      NSTG=' '//CNSTG(K)//G(GEN)
      ND=ND+SND(K)
      PERCENT=BASE(K)+F(K)*CDU
C
      RETURN
      END
C
C
      SUBROUTINE WLUMP(WSTG,WCDU,WNSTG,WCLS,WND,PERCENT)
```

```fortran
C     LUMPS WEEVIL STAGES TOGETHER FOR THE PRINTOUT.
C     HATCH INTO EGG STAGE
C     COCOON INTO PUPA STAGE
      CHARACTER*16 WSTG,WNSTG
      INTEGER      WCLS,WND,PERCENT
      REAL         WCDU,BASE(1:8),F(1:8)
      DATA  BASE(1),BASE(2),BASE(7),BASE(8)/0.0,50.0,83.3333,16.66667/
     +      F(1),F(2),F(7),F(8)/50.0,50.0,83.3333,16.66667/
C
      IF (WCLS .LT. 3) THEN
         WSTG='                 EGG'
         WNSTG=' LARVAL INSTAR 1'
         IF (WCLS .EQ. 1) WND=WND+3
      ELSE
         WSTG='              COCOON'
         WNSTG='           ADULT'
         IF (WCLS .EQ. 7) WND=WND+2
      END IF
      PERCENT=BASE(WCLS)+F(WCLS)*WCDU
      RETURN
      END
C
      SUBROUTINE ADVISE(ORG,CLS,CDU,NUM)
C     SEARCHES FOR APPROPRIATE ADVISORY IN INTERNAL LIST,
C     PRINTS THE ADVISORY.
      REAL     CDU
      INTEGER  ORG,CLS,NUM,M,I,AREP(1:7),WREP(1:9),BLREP(6:34),
     2         PTR(1:23)
      CHARACTER*76 REP(1:62)
      DATA  AREP/1,2,2,3,4,4/   WREP/5,7,8,9,10,11,12,12,13/
     2      BLREP/14,15,16,17,18,14,14,20,15,16,17,18,14,14,
     3            21,15,16,17,18,14,14,22,24,27,36,38,39,
     4            40,46,51,52,54,56,58,60,62/
     +      PTR/1,2,3,4,5,6,11,20,22,24,27,36,38,39,
C
      DATA REP/
     1'ALFALFA ADVISORIES',
     2'MAXIMUM PROTEIN LEVELS HAVE NOT BEEN REACHED.',
     2'MAXIMUM PROTEIN LEVELS HAVE BEEN REACHED.',
     3'PROTEIN LEVELS ARE NOW DECLINING.',
     4'PROTEIN LEVELS IN UNCUT ALFALFA CONTINUING TO DECLINE.',
C
C     WEEVIL ADVISORIES
     5'NO SCOUTING REQUIRED.',
     6'CHECK FOR OVIPOSITION.  PUNCTURES IN STEMS OF ALFALFA GROWING ON',
     6'SOUTHERLY SLOPES. USE EARLY WARNING SYSTEM TO ARRIVE AT A',
     6'TREAT/NO TREAT DECISION. IF NO TREATMENT INDICATED, RESAMPLE',
     6'WITHIN 3 OR 4 DAYS.  IF TREATMENT INDICATED, SPRAY IMMEDIATELY',
     6'WITH A PESTICIDE.',
     7'CHECK FOR OVIPOSITION PUNCTURES IN ALFALFA STEMS. USE EARLY',
     7'WARNING SYSTEM TO ARRIVE AT A TREAT/NO TREAT DECISION. IF',
     7'NO TREATMENT INDICATED, RESAMPLE IMMEDIATELY WITHIN 3 OR 4 DAYS. IF',
     7'TREATMENT INDICATED, HARVEST IMMEDIATELY IF CROP HAS REACHED',
     7'THE BUD STAGE AND THERE IS SUFFICIENT BULK. OTHERWISE SPRAY.',
     7'WITH A PESTICIDE.',
     7'CHECK FOR LARVAL FEEDING DAMAGE IN FOLIAGE OF ALFALFA GROWING',
     7'ON SOUTHERLY SLOPES. IF 25% OF STEMS SHOW FEEDING DAMAGE IN',
     7'TIPS, HARVEST OR SPRAY IMMEDIATELY. FOLIAGE, IF 25% OF STEMS',
     8'CHECK FOR LARVAL FEEDING DAMAGE IN FOLIAGE. IF 25% OF STEMS',
     8'SHOW FEEDING DAMAGE IN THE TIPS, HARVEST OR SPRAY IMMEDIATELY.',
```

```
12300      9'CHECK FOR LARVAL FEEDING DAMAGE IN FOLIAGE IF 50% OF STEMS'
12400      9'SHOW FEEDING DAMAGE IN THE TIPS, HARVEST OR SPRAY IMMEDIATELY.',
12500      0'CHECK FOR LARVAL FEEDING DAMAGE IN FOLIAGE IF 50% OF STEMS'
12600      0'SHOW FEEDING DAMAGE IN THE TIPS, HARVEST OR SPRAY IMMEDIATELY.',
12700      0'UNLESS LARVAL DISEASE IS EVIDENT, HARVEST OR SPRAY IMMEDIATELY',
12800      1'CHECK FOR LARVAL FEEDING DAMAGE IN FOLIAGE IF 50% OF STEMS',
12900      1'SHOW FEEDING DAMAGE IN THE TIPS AND LARVAL DISEASE IS NOT',
13000      1'EVIDENT, HARVEST OR SPRAY IMMEDIATELY',
13100      1'DAMAGE WILL REACH ITS PEAK WITHIN ',I2,' DAYS',  ***'/'''
13200      1'**  FOR CROPS CUT WITHIN PAST 10 DAYS   ***'/'''
13300      1'IF POPULATIONS WERE HEAVY AT TIME OF HARVEST, REGROWTH SHOULD'
13400      1'BE CHECKED FOR SIGNS OF CONTINUED FEEDING WHICH CAN RETARD',
13500      1'THE REGROWTH. WHEN THIS OCCURS, THE STUBBLE SHOULD',
13600      1'BE SPRAYED WITH A PESTICIDE',
13700      2'PEAK DAMAGE HAS NOW OCCURRED. SPRAYING IS NOT WARRANTED',
13800      2'CONTINUE TO CHECK REGROWTH FOR SIGNS OF FEEDING INJURY',
13900      3'PEAK DAMAGE HAS NOW OCCURRED. SPRAYING IS NOT WARRANTED.',
14000  C
14100      BLOTCH LEAFMINER ADVISORIES
14200      4'NO SCOUTING REQUIRED IN AREAS OF HIGH INFESTATION.',
14300      5'PINHOLING WILL BE EVIDENT IN ',I2,' DAYS',
14400      5'USE EARLY WARNING SYSTEM TO ARRIVE AT A TREAT/NOTREAT DECISION'
14500      5'IF NOTREATMENT INDICATED RESAMPLE IN 3 OR 4 DAYS, IF TREATMENT',
14600      5'INDICATED, HARVEST IMMEDIATELY IF CROP HAS REACHED BUD STAGE'
14700      6'WHERE PINHOLING IS SUFFICIENT BULK OTHERWISE SPRAY WITH A PESTICIDE.',
14800      6'ARRIVE AT A TREAT/NO TREAT DECISION IF NO TREATMENT INDICATED,',
14900      6'RESAMPLE IN 3 OR 4 DAYS. REACH THE TREATMENT INDICATED HARVEST'
15000      6'IMMEDIATELY IF CROP HAS REACHED BUD STAGE AND THERE IS',
15100      6'SUFFICIENT BULK OTHERWISE SPRAY WITH A PESTICIDE',
15200      7'IF MINING RATE IS 40%, HARVEST OR SPRAY IMMEDIATELY.',
15300  C
15400      8'DAMAGE WILL REACH ITS PEAK IN ',I2,' DAYS IF 30% OR MORE'
15500      8'OF THE LEAFLETS CONTAIN BLOTCH-TYPE MINES HARVEST IMMEDIATELY.',
15600      9'EMERGENCE OF FIRST GENERATION ADULTS HAS BEGUN.',
15700      9'EMERGENCE OF SECOND GENERATION ADULTS HAS BEGUN.',
15800      0'EMERGENCE OF THIRD GENERATION ADULTS HAS BEGUN.',
15900      1'EMERGENCE OF FOURTH GENERATION ADULTS HAS BEGUN.',
16000      0'NO SCOUTING REQUIRED'
16100      1'NO SCOUTING REQUIRED'
16200      1'NO SCOUTING REQUIRED'
16300      2'NO SCOUTING REQUIRED'
16400      2'NO SCOUTING REQUIRED'
16500      3'NO MORE ADVISORIES THIS SEASON.'/
16600  C
16700      DETERMINE ADVISORY NUMBER
16800      IF (ORG .EQ. 1) M=AREP(CLS)
16900      IF (ORG .EQ. 2) THEN
17000      M=WREP(CLS)
17100      IF ((CLS .EQ. 1) .AND. (CDU .GE. 0.80)) M=6
17200      END IF
17400      IF (ORG .EQ. 3) M=BLREP(CLS)
17500  C
17500      PRINT ADVISORY NUMBER M
17600      DO I=PTR(M),PTR(M+1)-1
17700      J=INDEX(REP(I),'',I2,'')
17800      IF (J .EQ. 0) THEN
17900      WRITE(6,'('' ''//REP(I)//'''')')
18000      ELSE IF (NUM.GE.0) WRITE(6,'('' ''//REP(I)//'''')') NUM
18100      END IF
18200      END DO
18300      END
```

```fortran
18400          WRITE(6,*) ' '
18500          RETURN
18600          END
18700  C
18800  C
18900          PARAMETER (FLOWER=7,HATCH=2,COCOON=7,AE=8,ADULTS=9)
19000          PARAMETER (ENDCROP=630,FINISH=930)
19100          CHARACTER*16 ASTG,WNSTG,WCLS,BLSTG,BLNSTG,TODAY*9,CR*1,LF*1
19200          INTEGER 1,D1,D2,WCLS,WMRD,WND,ACLS,AMRD,AND,AOFF,WOFF,
19300         2   BLOFF,MB,MMDD,MM,DD,YY,PERCENT
19400          REAL  BLCLS,BLMRD,BLND,BLCROP,BLCDU
19500          REAL  WCDU,ACDU,BLCDU
19600          DATA LF,CR/10,13/
19700  C
19800  C       FORMAT STATEMENTS
19900  601     FORMAT(' ',18X,A16,' EXPECTED WITHIN ',I2,' DAYS.')
20000  602     FORMAT('+',38X,' ; DEVELOPMENT= ',I3,'%;')
20100  603     FORMAT(' ',18X,A16,' PEAK EXPECTED WITHIN ',I2,' DAYS.')
20200  C
20300          OPEN(22,FILE='LFSTG',STATUS='OLD',ACCESS='DIRECT',READONLY)
20400          READ(22,1) AOFF,WOFF,BLOFF
20500  C
20600  C       ALFALFA STATUS
20700          READ(22,REC=AOFF) ACLS,ASTG,ACDU,AMRD,AND
20800          READ(22,REC=ACLS+1+AOFF) ANSTG,D1,D2
20900  C
21000  C       ALFALFA WEEVIL STATUS
21100          READ(22,REC=WOFF) WCLS,WSTG,WCDU,WMRD,WND
21200          READ(22,REC=WCLS+1+WOFF) WNSTG,D1,D2
21300  C
21400  C       BLOTCH LEAFMINER STATUS
21500          READ(22,REC=BLOFF) BLCLS,BLSTG,BLCDU,BLMRD,BLND
21600          READ(22,REC=BLCLS+1+BLOFF) BLNSTG,D1,D2
21700  C
21800          CLOSE(22,STATUS='KEEP')
21900  C
22000  C       PRINTOUT
22100          CALL DATE(TODAY)
22200  D        READ(17,1701) TODAY
22300  D1701   FORMAT(A9)
22400          WRITE(6,*) 'STATUS AS OF 00:00H',TODAY,LF
22500  C
22600  C       PAST END OF SEASON
22700          CALL IDATE(MM,DD,YY)
22800  D        READ(16,1601) MM,DD,YY
22900  D1601   FORMAT(3I2)
23000          MMDD=100*MM+DD
23100          IF (MMDD.GE.FINISH) THEN
23200            WRITE(6,*) 'THE SEASON IS OVER.  GOODBYE TIL NEXT YEAR.'
23300            GOTO 200
23400          END IF
23500  C
23600  C       ALFALFA PRINTOUT
23700  C
23800          IF (MMDD.LE.ENDCROP) THEN
23900            WRITE(6,*) LF,LF,CR
24000            WRITE(6,*) 'ALFALFA CROP STAGE :',ASTG
24100            IF (ACLS.LT.FLOWER) WRITE(6,601) ANSTG,AND
24200            CALL ADVISE(1,ACLS,ACDU,AMRD)
24300          END IF
24400  C       WEEVIL PRINTOUT
```

```
24500  C      PERCENT=100*WCDU
24600         IF (WCLS .LE. HATCH)
24700       2 IF ((WCLS.GE.COCOUN).AND.(WCLS.LE.AE))
24800       2 CALL WDUMP(WSIG,WCDU,WNSIG,WCLS,WND,PERCENT)
24900         CALL WDUMP(WSIG,WCDU,WNSIG,WCLS,WND,PERCENT)
25000         WRITE(6,*) 'ALFALFA WEEVIL STAGE :',WSIG
25100         WRITE(6,*) LF,LF,CR
25200
25300         IF (WCLS .LT. ADULTS) THEN
25400            WRITE(6,602) PERCENT
25500            WRITE(6,603) WNSIG,WND
25600            CALL ADVISE(2,WCLS,WCDU,WND)
25700         END IF
25800  C
25900  C      BLOTCH LEAFMINER PRINTOUT
26000  C
26100         PERCENT=100*BLCDU
26200         I=MOD(BLCLS,7)
26300         IF (I.EQ.0) I=7
26400         IF (I.EQ.4) BLDROP=BLND
26500         CALL ABLDUMP(BLSTG,BLCDU,BLNSTG,BLCLS,BLND,PERCENT)
26600         WRITE(6,*) LF,LF,CR
26700         WRITE(6,*) 'ALFALFA B. L. STAGE :',BLSTG
26800         IF ((CI.NE.1).AND.(PERCENT.GE.0)) WRITE(6,602) JMAXO(0,PERCENT)
26900         WRITE(6,603) BLNSTG,BLND
27000         D1=BLND
27100         IF (I.EQ.4) D1=BLDROP
27200  C
27300  C      APPROXIMATE NUMBER OF DAYS TO 50% HATCH (>=0).
27400         IF(I.EQ.1) D1=0.5+(0.5-BLCDU)*BLND
27500         CALL ADVISE(3,BLCLS,BLCDU,D1)
27600  C
27700  200    CONTINUE
27800         STOP ' '
27900         END
28000  C      END OF PROGRAM REPORT
```

```
C      6.6    UTIL.FOR
C
C      UTILITY PROGRAM FOR WRITING (CREATING) AND READING
C      SIMREVIL DIRECT ACCESS, RELATIVE FILES.
C
       INTEGER  FIRST,LAST
       PARAMETER (FIRST=92,LAST=274,NUMREG=3)
       CHARACTER*16 RELFILE,SEQFILE,BTC
       INTEGER       CLD,UTILITY,PRD,MAX,CLS,PRED,OBS,ADDRESS(2:18)
       REAL          CLD,S,1,MAX(FIRST:LAST),MIN(FIRST:LAST)
C
C      MAXI = MAXIMUM TEMP.
C      MINT = MINIMUM TEMP.
C      CLS  = CURRENT LIFE STAGE. NUMBER; 1 = EGG, ETC.
C      STG  = STAGE NAME.
C      CLD  = CUMULATIVE DEVELOPMENTAL UNITS
C      MRD  = MOST RECENT DAY OF PROCESSING
C      NXD  = NEXT DAY : PREDICTED NUMBER OF DAYS TO
C                        NEXT LIFE STAGE PEAK
C      PRED = PREDICTED DAY OF LIFE STAGE PEAK
C      OBS  = OBSERVED DAY OF LIFE STAGE PEAK
C
 101   FORMAT(2F6.1)
 102   FORMAT(13,A16,2F15,2)
 103   FORMAT(5F13.9,F5,1)
 104   FORMAT(<NUMREG>(25+1>I3)
 552   FORMAT(A16)
 601   FORMAT(A RECZ')
C
 1000  CONTINUE
C
C      WRITE = CREATES A DIRECT ACCESS, RELATIVE FILE FROM DATA
C              STORED IN A SEQUENTIAL FILE ALREADY ON DISK
C      READ  = READS A DIRECT ACCESS, RELATIVE FILE.
C              OUTPUT IS DIRECTED TO STANDARD PRINT UNIT ( FOR006 ).
C
       WRITE(6,660)                                  TEMP LIFE//
 660   FORMAT(' 1,2,(UTILITY CODES'/)
     1        ' WRITE'/215/' READ ',215)
       WRITE(6,*) ' UTILITY?'
       READ(5,501) UTILITY
       IF ((UTILITY .LE. 0) .OR. (UTILITY .GT. 4)) GOTO 2000
       WRITE(6,*) ' RELATIVE FILE?'
       READ(5,552) RELFILE
C
       IF (UTILITY .LT. 3) THEN
          WRITE(6,*) ' SEQUENTIAL FILE?'
          READ(5,552) SEQFILE
          IF (UTILITY .EQ. 2) J=8
          IF (UTILITY .EQ. 1) J=2+LAST-FIRST
          OPEN(1,FILE=SEQFILE,STATUS='OLD')
          OPEN(2,FILE=RELFILE,STATUS='NEW',ACCESS='DIRECT',RECL=1,INITIALSIZE=3,
     1         ORGANIZATION='RELATIVE')
          RECLENGTH=3)
       END IF
C
       IF (UTILITY .GT. 2) THEN
          OPEN(2,FILE=RELFILE,STATUS='OLD',ACCESS='DIRECT')
          IF
```

```fortran
6200  C     CASE STATEMENT TO CHOOSE UTILITY
6300        GOTO (410,420,430,440),UTILITY
6400        GOTO 500
6500  C
6600  C     WRITE TEMPERATURE FILE
6700  410   I=FIRST
6800  411   READ(1,101,END=412) MAXT(I),MINT(I)
6900        I=I+1
7000        GOTO 411
7100  412   WRITE(2,1) (MAXT(I),I=FIRST,LAST)
7200        WRITE(2,2) (MINT(I),I=FIRST,LAST)
7300        GOTO 500
7400  C
7500  C     WRITE LIFE STAGE FILE
7600  420   READ(1,107) (ADDRESS(I),I=1,NORGS+1)
7700        WRITE(1,107) (ADDRESS(I),I=1,NORGS+1)
7800        DO J=1,NORGS
7900          READ(1,102) CLS,STG,CDU,MRD,NXD
8000          WRITE(2,REC=ADDRESS(J)) CLS,STG,CDU,MRD,NXD
8100          DO I=ADDRESS(J)+1,ADDRESS(J+1)-1
8200            READ(1,103) STG,PRED,OBS
8300            WRITE(2,REC=I) STG,PRED,OBS
8400          END DO
8500        END DO
8600        GOTO 500
8700  C
8800  C     READ TEMPERATURE FILE
8900  430   READ(2,1) (MAXT(I),I=FIRST,LAST)
9000        READ(2,2) (MINT(I),I=FIRST,LAST)
9100        DO I=FIRST,LAST
9200          WRITE(6,101) MAXT(I),MINT(I)
9300        END DO
9400        GOTO 500
9500  C
9600  C     READ LIFE STAGE FILE
9700  440   READ(6,107) (ADDRESS(I),I=1,NORGS+1)
9800        WRITE(6,107) (ADDRESS(I),I=1,NORGS+1)
9900        DO J=1,NORGS
10000         READ(2,REC=ADDRESS(J)) CLS,STG,CDU,MRD,NXD
10100         WRITE(6,102) CLS,STG,CDU,MRD,NXD
10200         DO I=ADDRESS(J)+1,ADDRESS(J+1)-1
10300           READ(2,REC=I) STG,PRED,OBS
10400           WRITE(6,103) STG,PRED,OBS
10500         END DO
10600       END DO
10700       GOTO 500
10800 C
10900 500   IF (UTILITY .LT. 3) CLOSE(1,STATUS='KEEP')
11000       CLOSE(2,STATUS='KEEP')
11100       WRITE(6,*) ' '
11200       GOTO 1000
11300 2000  CONTINUE
11400       STOP 'END UTILITY'
11500       END
```