A NOTE ON REPORTED CASES OF ENCEPHALITIS AND SOIL TEMPERATURES IN COLORADO[1]

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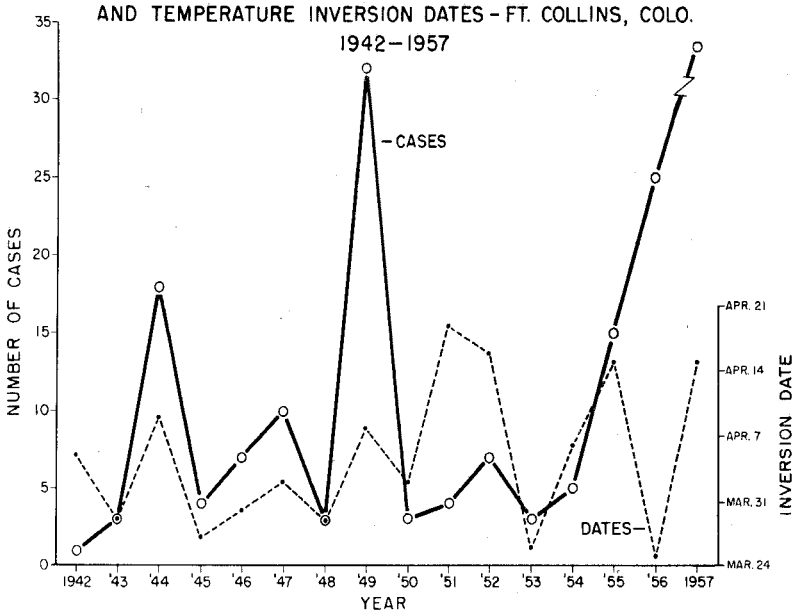
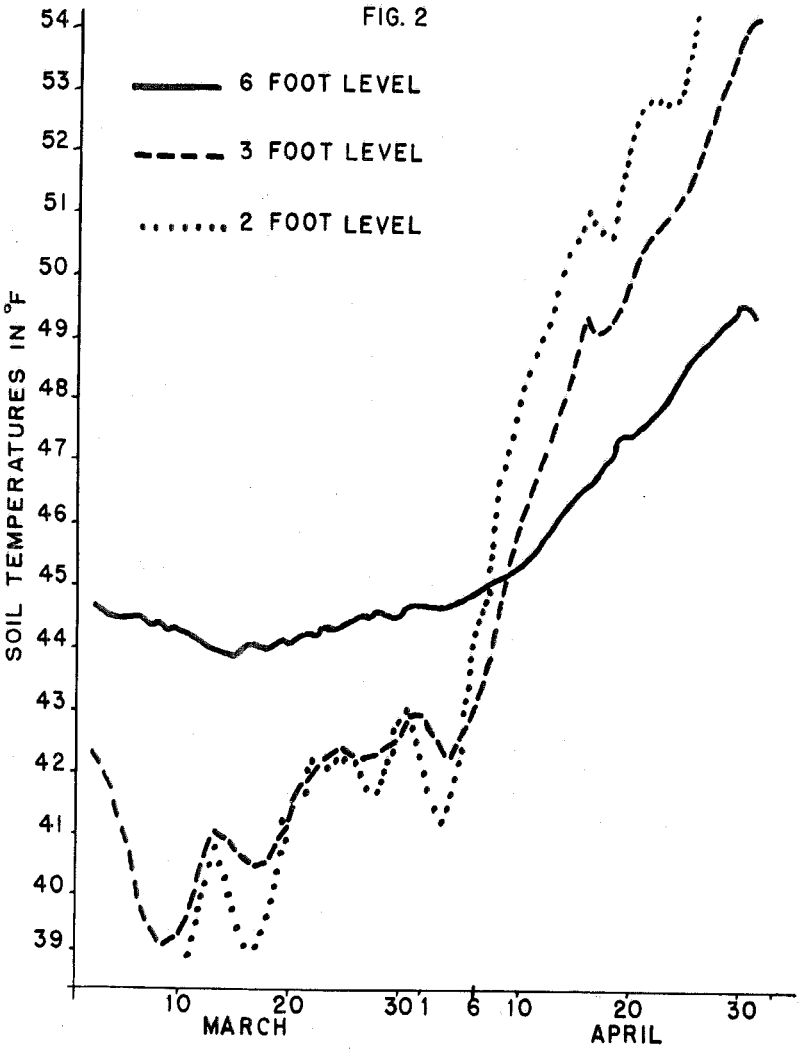
A possible relationship between encephalitis virus activity and the date of the spring soil temperature inversion may provide the earliest seasonal indication of a potential increase in the mosquito-borne virus. This interesting association may be seen in Figure 1 which shows spring soil inversion dates and the number of reported cases of encephalitis in eastern Colorado for a period of sixteen years, 1942–1957.

FIG. 1



The inversion date (Fig. 2) marks the temperature change of the surface soil from colder, to warmer than the subsoil, and in the Colorado area denotes the beginning of the *tarsalis* season, since *Culex tarsalis* emerges from hibernation immediately after this date (Bennington, Blackmore and Sooter, 1958). This temperature inversion is not clear-cut in some years, i.e., 1944, 1945, and 1953 as shown in Table 2, there being a return to winter soil temperatures and a second or rarely a third inversion. When more than one inversion occurs, it is impossible, with the data now available, to determine which date marks *Culex tarsalis* emergence; therefore the date of the first inversion (Table 2) was arbitrarily chosen for Figures 2 and 3.

[1] United States Department of Health, Education and Welfare, Public Health Service, Bureau of State Services, Communicable Disease Center, Atlanta, Georgia.



A SOIL TEMPERATURE INVERSION WHICH OCCURRED AT FT. COLLINS, COLORADO, MARCH 6, 1954

TABLE 1.—Reported cases and deaths of encephalitis
Northeastern counties of Colorado

County	1942		1943		1944		1945		1946		1947		1948		1949		1950		1951		1952		1953		1954		1955		1956	
	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D
Adams					1	—									2	1					1	—	—	1	2	—	4	2	6	—
Arapahoe			1	—	2	—					2	1			7	1	1	—	1	—	2	—					3	1	4	—
Cheyenne																														
Denver					3	—	2	—	3	—			—	(1)	1	(7)			—	(2)	1	(2)	—	2			5	1	10	1
Douglas																														
Elbert											1	—																		
Kit Carson															1	—									1	—	1	—	2	—
Lincoln																														
Logan	—	(1)							1	—					2	2														
Morgan					—	(1)					1	—	1	(2)	2	—			1	—	1	—					1	—		
Philips																									—	(1)	1	—		
Sedwick					1	1					2	—			1	—														
Washington															3	—														
Weld			2	—	10	—	2	—	3	—	3	—			6	1	2	1			—	(1)			1	—			1	—
Yama											1	—			1	—													2	—
	—	1	3	—	17	2	4	—	7	—	10	1	1	3	26	12	3	1	2	2	5	3	—	3	4	1	15	4	25	1
Deaths not reported as cases (figures in parentheses)					1								2		6				2		2				1					
Total	1		3		18		4		7		10		3		32		3		4		7	3			5		15		25	

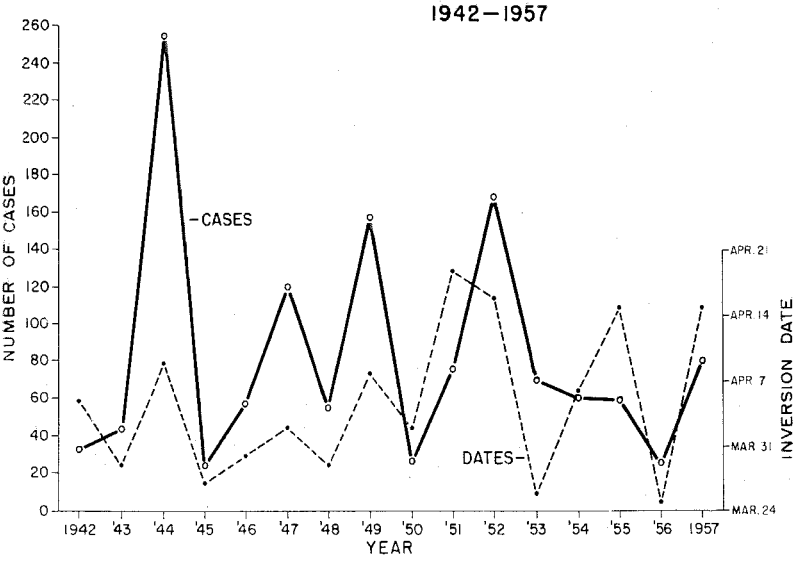
Source of data: 1942–1946, National Office of Vital Statistics; 1957—a total of 133 cases were confirmed by laboratory test with onsets in 1957. Personal communication, Dr. Luther Giddings, Greeley Field Station, Communicable Disease Center.

TABLE 2

Year	Ft. Collins inversion[1] date	Number human cases[2] Eastern Colorado encephalitis	Number equine cases[3] Colorado state	Horse population in affected areas	Rate per 1,000 horses
1942	April 5	1	33	90,414	0.4
1943	March 29	3	44	58,787	0.7
1944	April 9 (27)	18	255	103,544	2.5
1945	Mar. 27 (Apr.9)	4	24	79,623	0.3
1946	March 30	7	57	62,247	0.8
1947	April 2	10	120	87,008	1.4
1948	March 29	3	45	61,477	0.7
1949	April 8	32	157	86,111	1.8
1950	April 2	3	26	56,505	0.5
1951	April 19	4	76	49,038	1.5
1952	April 16	7	168	58,289	2.9
1953	Mar. 26 (Apr. 27)	3	70	15,796	4.4
1954	April 6	5	60	13,565	4.4
1955	April 15	15	59	25,517	2.3
1956	March 25	25	25	23,128	1.1
1957	April 15	N.A.	80	32,324	2.5

[1] Alternative dates (figures in parentheses) omitted in graphs.
[2] Summary line from Table 1.
[3] Source of data: U.S.D.A., Agricultural Research Service.

Fig. 3: REPORTED ENCEPHALITIS CASES IN EQUINES — COLORADO AND TEMPERATURE INVERSION DATES — FT. COLLINS, COLO. 1942—1957



The median date of the temperature inversion at Ft. Collins, Colorado, for the past sixteen years is April 5, ranging from March 25 to April 19, with two-thirds of the dates extending from March 27–April 15.

The inversion date is one of a number of environmental and climatological indices used in the control of various predatory agricultural insects. Wheat growers consult their county agricultural agents for weather data on safe sowing dates to reduce Hessian fly damage; bean growers obtain planting dates, which vary from year to year (Baker and Mathews, 1952), to avoid the seed corn maggot. A migration of white grubs follows the spring soil temperature inversion, and the date of this phenomenon provides a timing (McColloch and Hayes, 1923) for one method of control of these larvae.

Although the diagnosis of encephalitis is difficult and the reported case and death data may reflect entities other than encephalitis, or the reported data may be deficient as an indicator of the number of cases occurring in a given locality, such data as are available on this disease are shown in Table 1 for 15 northeastern Colorado counties. Table 2 shows the inversion dates and the reported human cases on which Figure 1 is based. The incidence of cases of encephalitis appears to vary in accordance with the change in the inversion date, i.e., more cases when the inversion date is late in the spring, fewer cases when the date is early. The number of cases, however, is not directly proportional to the difference in days between inversion dates of successive years. And in one instance there was an inverse relationship: in 1956 the cross-over in temperatures occurred early, but the number of encephalitis cases reported was considerably larger than in the preceding year.[2] However, the general concordance between reported cases and annual fluctuation in spring soil inversion dates is of interest; especially so, since there is the suggestion that a shorter *tarsalis* season apparently has a greater potentiality of virus activity than a long season which begins earlier in spring.

Fig. 3 shows the trend of inversion dates at Ft. Collins, Colorado. The reported horse (and/or mule) cases of encephalitis are given in Table 2 for the entire state of Colorado. The same general conclusion may be drawn from this graph: when the inversion date occurs late in the spring, more horse encephalitis cases were reported.

The date of soil temperature inversion appears to be related to the human and horse cases of encephalitis which occur later in the summer and early fall. There is an interval of time between the date of inversion and the "encephalitis season" of at least two months when other ecologic factors are contributing to a mosquito-virus build-up. The mechanism whereby a virus build-up is produced when the *tarsalis* season is reduced remains to be explored.

Soil temperatures can be taken by means of inexpensive thermistors or thermometers buried in the soil at depths of 1, 3 and 6 feet; and such data are already being recorded by some Agricultural Experiment Stations and United States Weather Bureau Stations. For a selected locale, these data and the index of mosquito population maintained by the local mosquito abatement service may provide a clue in spring to the later seasonal activity of mosquito-borne encephalitis viruses.

[2] The number of cases in 1953 was larger than any other year in the period studied. For this year two inversions occurred—one very early and one very late.

References

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