

AN ANALYSIS OF THE WEEDS OF KNAPP FARM FROM THE STANDPOINT OF PLANT INVASION¹

FRANCES R. BOTTUM

INSTRUCTOR IN BIOLOGY, GEORGE PEABODY COLLEGE FOR TEACHERS

Weeds have been aptly described by Brenchley as the inevitable corollaries of crops. The toll which they exact from us is strikingly illustrated by the situation in Indiana in the year 1921. It was estimated by Hansen² that the cost of weeds in one year was \$44,000,000 in that state, or \$14 per capita. The loss due to reduced crop yield alone was almost \$9 per capita.

Just why weeds reduce the crop yield is not yet quite clear. There is light, food, and moisture sufficient usually for both crops and weeds.³ This is contrary to some of the reasons commonly advanced to account for the noxious character of weeds.

The greatest loss after that due to reduced crop yields, is due to the cost of tillage which falls most heavily on intertilled crops. An intertilled crop in which weeds have been allowed to grow unmolested is usually an entire failure.⁴ In the Indiana investigation, the tillage loss alone was found to amount to \$11,105,450. American farm tillage comprises from 30% to 40% of the total cost of farm operation.

In view of the importance of the weed problem, a study was made of the plants of a Tennessee farm from the standpoint of the paths of invasion. It was undertaken at the suggestion of Dr. Jesse M. Shaver, and under his direction. The farm chosen was Knapp Farm, belonging to George Peabody College for Teachers and situated six miles east of Nashville on the Elm Hill Pike. It is fairly representative of the better class of dairy farms of middle Tennessee. It is about five hundred acres in extent and spreads like a fan from a hilltop down to a creek. The general slope is downward toward the north. There are many natural lines of drainage such as gullies, wet-weather streams, underground streams, and sink holes. Terracing has been freely used to prevent soil wash.

About two hundred species of weeds or plants which must be regarded as potential weeds were identified on Knapp Farm. Of these, forty are known to have migrated from Europe and Asia to the United States, and eight from tropical America.

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²Hansen, A. A., 1921. The Toll of Weeds in Indiana. Proc. Indiana Acad. Sci., 1921: 105-109. Abstract E. S. R., 48: 441 (1923).

³Cates, H. R., 1916. The Weed Problem in American Agriculture. U. S. Dept. Agric. Yearbook, 1916: 205.

⁴Cates, H. R., *op. cit.*

Of the plants of European origin, three have early records, namely, crab grass (*Digitaria sanguinalis* (L.) Scop.), prickly lettuce (*Lactuca scariola* L.), and blue grass (*Poa pratensis* L.). Crab grass arrived early in this country, and has become thoroughly established. It was described as early as 1775, by Romans⁵ in his *Natural History of East and West Florida*, in which an account of its habits as one of the "artificial" grasses of Florida is given.

Prickly lettuce, which is as yet of uncertain and sporadic occurrence, was noted in an early catalog, and first appeared in Massachusetts in 1863. Although it spread to many parts of the country, it passed for a long time unnoticed by botanists. Kentucky blue grass was first identified on this continent by Kalm, in 1751, in Montreal. It had probably been taken by the French to Indiana and Illinois in about the year 1700. From these states it spread into Ohio and Kentucky, where the English found it growing abundantly as if an indigenous species, by 1750.⁶

From tropical America have come three of our worst weeds, green amaranth (*Amaranthus hybridus* L.), thorny amaranth (*Amaranthus spinosus* L.), commonly called "pig weeds," and the Jimson weed (*Datura tatula* L.). Purposely introduced from South America for ornamental purposes are the morning glories (*Ipomoea hederacea* Jacq. and *I. purpurea* Roth), and the apple of Peru (*Nicandra physaloides* (L.) Pers.).

From Asia the very common Japanese honeysuckle (*Lonicera Japonica* Thunb.) was introduced. Velvet leaf (*Abutilon Theophrasti* Medic.) came from India. Annual wormwood (*Artemisia annua* L.) is recorded as coming from the "Old World," there being some uncertainty as to just where its original home was. The common nightshade (*Solanum nigrum* L.) is cosmopolitan, although it appears as if introduced.⁷

In 1895, the United States Department of Agriculture in its Yearbook⁸ printed a list of the two hundred weeds which appeared to be of the greatest importance in this country. Of these, sixty-five species occur on Knapp Farm, twenty-seven being indigenous to the United States, and thirty-eight being native to foreign countries.

Many of those native to the United States did not occur in Tennessee originally. From the prairie states came the bracted plantain (*Plantago aristata* Michx.). The buffalo-bur (*Solanum rostratum* Dunal.) has recently come into Tennessee and into the neighborhood of Nashville from the Rocky Mountains, but has not yet been seen on Knapp Farm. From the Northern states climbing false buckwheat (*Polygonum scandens* L.) has migrated. Horse nettle (*Solanum caro-*

⁵Carrier, Lyman, 1923. *The Beginnings of Agriculture in America*. New York. McGraw-Hill Book Company, Inc. See page 243.

⁶Carrier, *op. cit.*

⁷Gray, Asa, 1908. *New Manual of Botany*. Seventh Edition. New York. American Book Company. See pages 371, 372, 670, 713-717, 755, 850.

⁸Yearbook of the United States Department of Agriculture. 1895. Washington, D. C. Government Printing Office, 1896.

linense L.), and the giant ragweed (*Ambrosia trifida* L.) are among those which have migrated from the South northward.⁹

The distribution of the plants of the area studied with regard to their origin is about what one would expect in Tennessee. Most of the noxious weeds of the Eastern states are of European origin. They have largely displaced the native plants. In the extreme Southwest, and especially in Texas, on the other hand, the weeds are indigenous save for a very few which migrated from tropical America, and one or two European plants. It is characteristic of the Mississippi valley, of which Tennessee is a part, that its weed flora, while containing many European weeds which have found their way across the Appalachian Mountains or by other routes into the valley, yet comprise many species which are indigenous to the soil.¹⁰

The avenues on Knapp Farm for the invasion of plants from outside sources are numerous. Among these are two public highways. Elm Hill Pike, a hard-surfaced road, passes along the southern border of the farm and through it for approximately a mile. Vehicles and animals are the chief agents for plant migration here. Seeds blown from the road to suitable ground may germinate and so start a center for local invasion of the fields. The species of this roadside are so common on other parts of the farm that apparently invasion of the fields from the road has been going on for some time. Perhaps invasion of the roadside, on the other hand, has occurred from the farm. No evidence that new species were at present being introduced in this manner was found.

Much more interesting was the railway right-of-way. For one and an eighth miles the Nashville and Chattanooga Railway traverses the middle of the farm. Plants found nowhere else on the farm were found here. Some appear for a short time and then disappear as is so characteristic of ballast plants. Many establish themselves and persist but never invade the fields. Still others have apparently become common in other places, or were established elsewhere and then migrated to the railway track from the fields. The railway is at the present time the most conspicuous means for the entrance of new species. Seeds may become entrapped temporarily in the wrappings and crates around freight packages, and be dropped from time to time. They may drop from a cargo of grain or of farm animals. They may be transported in railway ballast itself or cling to new ties.

When this study was started the railway track was being covered with fresh ballast of crushed stone, and new ties were laid in various places. Almost immediately new plants appeared which had not been noted before. Most conspicuous of these is the small-flowered white morning glory (*Ipomoea lacunosa* L.). The occurrence of button weed (*Diodia virginica* L.) here is remarkable since its usual habitat is low ground along streams, yet it appears to be doing well and is spreading

⁹Pammel, L. H., 1912. Weeds of the Farm and Garden. New York. Orange Judd Co. See page 85.

¹⁰Pammel, *op. cit.*, pages 76-86.

over the hard stone ballast freely. Round-leaved toadflax (*Linaria spuria* (L.) Mill), tiny love grass (*Eragrostis capillaris* (L.) Ness), and possibly twining tragia (*Tragia macrocarpa* Willd.) have succeeded in migrating from the roadbed to the bank and fences some distance from the rails. The latter is a plant not easily overlooked as it is very painful to the touch, is beautiful, and bears fruits which are red and as large as wild strawberry. Wild bergamot (*Monarda fistulosa* L.) appeared here for the first time within the farm and after only three years has trebled the number of plants. Bouncing Bet (*Saponaria officinalis* L.), always sporadic in occurrence, and tall red top (*Triodea flava* (L.) Hitchc.) were found only where some railway ties had laid for some time. Altogether seventeen species, found nowhere else on the farm, and not listed in a study previously made by Marjory Ruth Ross¹¹ occurred along the railway track.

One of the important avenues of invasion is Mill Creek. Mill Creek flows for a distance of about one and one-quarter miles along the north and northwest borders of the farm. It meanders over a bed of horizontal rock strata in which occur crevices of joint planes frequently at right angles to the direction of the current. Deposition is occurring rapidly on the inner curves and islands are being formed in the middle of the bed. The banks are, however, for the most part steep and terraced. Both the islands and the banks, except where the rock crops out in vertical cliffs, are cut with steep ravines and gullies.

A striking characteristic of the vegetation along Mill Creek is the large number of species and ecological types represented. Some species may have been there for a long time and the rest have come there in a variety of ways. It is probable that some were deposited by the creek, especially the dominant hydrophyte (*Dianthera americana* L.), and the semi-hydrophyte (*Eleocharis macrostachya* L.). Factors affecting the importance of the creek as a path of invasion were found to be numerous. Among these the slowness of the current in places, and the islands seemed to offer the most favorable conditions for deposition of seed or fragments of plants, whereas unfavorable conditions are the fluctuating volume of water and the instability of the soil of the banks. Just what species were migrating in this way was not determined.

The plants of the creek bank which are able to withstand dry soil and waste ground are the ones likely to appear in the pastures and fence rows adjacent to the creek. Such is apple of Peru (*Nicandra physaloides* (L.) Pers.), which appears only in the uncultivated fence corners near the creek, and on the creek bank, and may have invaded from the creek bank.

Aside from the highways and water course, other avenues of invasion are the rather obvious ones, namely, fertilizers, animals, feed, commercial seeds brought from outside, soil transported for special purposes, birds, winds, storm columns, and possibly at times snowdrift.

¹¹Ross, Marjory Ruth, 1924. The Weeds of Knapp Farm. Unpublished Master's Thesis, George Peabody College for Teachers.

No fertilizers not previously treated with chemicals had been used recently on the farm. Ground limestone was used in one field as a corrective, but no evidence was found that new plants had been transported by this means. A few sheep were bought and might have been the means of introduction of weeds. Members of the borage family, well represented in a cedar pasture on the farm, are notorious for traveling in the wool on sheep from Western stock farms.

Food for farm animals and commercial seed are said to be the most prolific source of weed infestation known. The feed brought to Knapp Farm from outside consists chiefly of oats and bran. Bull thistle, cheat, yarrow, corn cockle, green foxtail grass, and horse nettle are the weeds on the farm which could easily have been introduced in feed. Little ground feed is ever brought to Knapp Farm. Seeds of lamb's quarters (*Chenopodium album* L.), because of their flinty nature, and of tumble mustard (*Sisymbrium altissimum*), because of their very small size, escape being crushed, hence are among the few weeds disseminated in ground feed.¹² The former is abundant on the farm, the latter has been found there by Dr. J. M. Shaver, but has not established itself.

Weeds introduced in commercial seed are probably numerous. The ones noted, however, are such as have some forage value. In a field sown to alsike clover were found plants of red clover, alfalfa, and of sweet clover. Corn cockle was probably introduced in this manner but has not become established. Soil has not been transported into the farm for special purposes, and has not, therefore, been the means of introducing plants.

Much remains to be done in the study of birds as a means of dissemination and invasion of plants. That they are important at least locally is beyond doubt. No special study of this means of invasion was made in the fields. Among the plants on the farm whose seeds are eaten by birds are the blackberry, pokeweed, black nightshade, and poison ivy.¹³ Pigeon grass, knot grass, dandelion, thistle, and ragweed are carried by the cowbird, by the red-winged blackbird, and by sparrows. It is not known how far the seeds are carried, possibly not far at all, since the birds that carry them do not fly with full crops.¹⁴ The most striking case of apparent agency of birds in seed dissemination was seen in one of the centers of local invasion. Several steel towers of an electrical transmission line stand in one of the large fields in which hay crops are usually grown. Under these towers which are used freely as perching places, and are far away from any trees, the dominant species are such as are reputed to be carried by birds, namely, blackberry (*Rubus* sp.), climbing rose (*Rosa setigera* Michx.), and pokeweed (*Phytolacca decandra* L.). Buckbush (*Symphoricarpus orbiculatus* Moench.), plentiful here, is not, however, known to be carried by birds.

¹²Dymond, J. R., 1915. Grain Screenings with Results of Feeding Experiments. Bulletin of the Canada Department of Agriculture. Abstract, E.S.R., 34 (1916).

¹³Brenchley, W. E., 1920. Weeds of Farm Land. London. Longmans, Green and Co. See page 28.

¹⁴Dewey, Lyster H., 1896. Migration of Weeds. Yearbook of the United States Department of Agriculture, 1896: 271.

Knapp Farm presents, perhaps, more than the usual number of centers of local invasion from which plants migrate into cleared land. There are natural lines of drainage, gullies, wet weather stream beds and sink-holes, and the terraces constructed to control the drainage, all of which give plants opportunity to get a foothold where cultivation will not interfere. The creek bank, the railway and fence rows, the crossroads within the farm, the lanes, some rock piles, the land near the farm buildings, several tree islands, and the electric transmission towers all form obstructions to farm machinery and tillage.

Of these centers of invasion the most interesting, though perhaps not the most important, are the sink-holes. Because of the growth of trees and shrubs about them, they stand out conspicuously in the field. The sink-holes differ among themselves in the character of their plant life, each offering its own special problem with regard to plant succession. These differences are apparently due to differences in the thickness of the over-lying soil and in its moisture content. In the cedar pasture, stone crop (*Sedum pulchellum* Michx.) and prickly pear (*Opuntia Rafinesquii* Engelm.), two xerophytic plants, are characteristic of the vegetation about the sink holes. In the meadow, where there is far more moisture, some distinctly mesophytic plants such as a false nettle (*Boehemeria cylindrica* (L.) SW.) are found.

Invasion of new territory by any species of plant implies some means of distribution. The methods of distribution are many and various and have been frequently described. Nearly all well known methods which are dependent upon structures or adaptations which are of advantage to a plant in dispersal, are abundantly represented among the species at Knapp Farm. A few interesting combinations of structures favorable to dispersal were found.