

ville, July; North Little Rock, August; Prescott, May; Ozone, September, and Hot Springs, June. It seems to like to rest on *Sabina virginiana* L. (red cedar) rather than to feed on flowers.

#### 11. *Incisalia irus* (Godart)

The only individual of this species that I have seen from Arkansas was a male collected by Paul McHenry about a mile north of Conway, in late March, 1929. Austin Clark<sup>2</sup> illustrates a specimen from Arkansas in his monograph, "Butterflies of the District of Columbia and Vicinity." More collecting during March and early April in northern Arkansas will probably result in the finding of this species more abundantly.

#### 12. *Incisalia niphon* (Huebner)

I took a female (in March, 1933) about a mile north of Conway. This is my only specimen from Arkansas. I found this individual sitting on a stunted oak tree on a low hill. No other species of hairstreaks were in evidence there on that day.

## Increase of Poison-Bitterweed (*Hymenoxys odorata*) on Texas Range Lands

V. L. Cory<sup>1</sup>

This paper, as read before the Texas Academy of Science, was titled "Increase of Native Weedy Forbs on Texas Range Lands." The reason for the change of title here is that, from a range standpoint, not all forbs are weeds and not all weeds are forbs. Forbs are herbaceous plants that are not grasses or grass-like plants. Some of the forbs are toxic to livestock or so unpalatable to them they feed upon them only when excessively hungry or starving. In reality some of these range forbs are forage plants and some are not.

"Weeds" on the farm is not synonymous with "weeds" on the range; and if one does not make this distinction, he causes confusion. On the range, there are times when the grasses are not green and succulent while some of the forbs are. At such times, when the palatable forbs are in sufficient

<sup>2</sup>Bull. 157 U.S. Nat. Mus., 1932.

<sup>1</sup>Field Botanist, Southern Methodist University Herbarium, Dallas. Cf. V. L. Cory, "The Disappearance of Plant Species from the Range in Texas," (FIELD & LABORATORY, XVII, 99-115, 1949.)

abundance, they supply all or nearly all the grazing of both sheep and goats. Even when the grass is in good condition both sheep and goats tend to favor some of the more desirable forbs. While many forbs are perennial, the desirable ones are annuals, dependent upon seed for their reproduction. When not allowed to reproduce themselves, such plants disappear from the range.

On the other hand, forbs not palatable, or even toxic to livestock reproduce themselves with little or no hindrance. It turns out that the highly palatable grasses are fed upon so excessively that those species are weakened or even destroyed. Examples of this may be found in ranges in which every island or area once bearing the turf grasses, buffalo and curly mesquite, no longer bear any perennial grasses. In the early growing season, such areas may be occupied by annual grasses, which mature quickly and disappear; but usually they become fully occupied by weeds, some of which may be toxic to livestock.

Concrete examples of such increase of weeds on a range come out in some of my range experiences.

In September, 1923, I became Grazing Research Botanist of the Texas Agricultural Experiment Station. My headquarters were Substation No. 14—popularly known as the Ranch Experiment Station—which is on the Edwards Plateau about midway between the towns of Sonora and Rocksprings and about 100 miles south of San Angelo. This Station has five sections of range land, the major portion of which lies in Edwards County while some is in Sutton County. Practically all my available time for the first six months or so was spent in the various pastures where, with the aid of a detailed soil survey map, I became familiar with the range livestock, and the topography and vegetation of each pasture. After that my work began.

At that time there was not much infestation by weeds of the grassland of the range, but forbs that were forage plants were in some variety and abundance. I early became familiar with some spots later known as "bitterweed hazard areas." These were lake-beds or flat and stony areas at the head of draws in which grass was seriously deficient or lacking and where the dominant vegetation was a forb, *Hymenoxys odorata* DC. This species for much of the season bore numer-

ous heads of yellow flowers and its leaves and stems were exceedingly bitter. Even though this plant is not the bitterweed of central Texas and eastward, the plant of West Texas had become known by that name. The eastern bitterweed is non-toxic to livestock; as a consequence our western plant sometimes has been distinguished by the name of "poison-bitterweed."

Late in 1923 a study of the carrying capacity of the range was instituted, and such work is complete for the five years of 1924-28. The unit selected for this study represents the grazing of a mother cow of average weight continuously throughout the year. The average weight of our mother cows proved to be 893 pounds. At the beginning, the stocking of our range was in excess of 70 units per section of land. To provide these 70 units three types of range livestock—cattle, sheep, and goats—were grazed in calculated proportions of each, in an effort better to utilize the forage of the range. This rate of stocking soon was found to be excessive and was reduced somewhat, the average for the five years of 1924-28 being 66 units to the section.

At the beginning of my work, there was no idea among ranchmen that the range had become impoverished, and their awakening to the situation was delayed for years. Ranchmen were heard to say that they wanted weeds in their pastures—and they certainly were getting them. In the early winter of 1923-24 there were scattering fatalities on ranges having "bitterweed hazard areas," including the loss of one ewe in a Station pasture. I found the dead animal myself, and the clues convinced me of the cause of her death. It was years before it became generally recognized that the plant involved was poisonous. Consequently, it was years before any serious effort was made to study the situation and to do something about it.

In the early winter of 1930-32, poison-bitterweed had seriously encroached on grassland areas of our range. Every suitable habitat had become infested with the plant. Elsewhere in the general area the losses of sheep from feeding upon green and succulent plants of this weed in the winter months were very large— as much as half or more of the entire flock. Since adequate care and attention were given to the Experiment Station sheep the losses there were negligible.

Late in 1931 I began a 15-year study of the bitterweed problems on our range. An area of infestation by poison bitterweed was selected in three of our pastures, I, B, and F, in ascending order of density of infestation. The least infested area was the one farthest from the watering place, the youngest in date of original infestation, and with greatest density of curly mesquite grass. It was in a flat valley. Next in order was an area on a gentle slope which once had a nice covering of curly mesquite. Its location in the corner of the pasture where water and salt troughs were placed became the favorite bedding ground for both sheep and goats; and the grass, consequently, had become almost eliminated. The maximum infestation was in an original "bitterweed hazard area," and hence the oldest in age. It was in a flat opening into a draw and was relatively near to watering and salting facilities. A pair of quadrats were located in each of these three areas, not adjacent but nearby. One of these quadrats was made an enclosure; the other was left open. The original counts of poison bitterweed seedlings for each quadrat-pair were nearly the same: and for the three pastures (in the order already given) were some  $3\frac{1}{2}$  million,  $5\frac{1}{2}$  million, and  $7\frac{1}{2}$  million plants to the acre. In the two higher counts grass was absent. Thereafter, at a proper time, I twice each year made counts of all plant species found in each of the six quadrats. During this period the rate of stocking was reduced further, to encourage recovery of these areas by grass.

Elsewhere, in areas containing poison bitterweed, detailed counts of plants were made in every month of each year. Of all these counts, the highest for poison bitterweed (a rate of stand in excess of 9 million plants to the acre) was found one winter in the "bitterweed hazard area" in which the dead ewe was found in 1923. In the case of poison bitterweed, count-results are at a maximum when the seedlings are about two inches tall, and become reduced thereafter through intense competition with other plants (the reduction being greatest in dry periods). At maturity, poison bitterweed shows a reduction of a third to one-half or more. Thus reduced the plants grow larger and produce very much more seed, while in dense stands they are stunted, produce few heads (sometimes only one or two) with markedly fewer

achenes. An estimate based upon extensive observation indicates that a stand of 500,000 to 750,000 plants per acre produces a maximum seed crop. Because the seed crop in dense stands is greatly reduced, some men have believed (erroneously, I think) that this plant would grow in increased abundance up to a point where it would eliminate itself. A heavy seed crop sooner or later most certainly would produce a dense stand of the plant, but not necessarily the succeeding season. Satisfactory germination takes place only when autumn and early winter rainfall is adequate. In this species the achenes instead of being released from the head at maturity (the usual case with composites), are sealed by the involucre bracts into compact heads in perfect safety, and may remain viable for some years. These involucre bracts open only when in contact with sufficient moisture and usually only when lying on the ground or imbedded therein; they then spread widely and the achenes are freed. Subsequently they become dispersed through run-off rainfall or by other means. The spread of the plants tends toward lower levels and along water courses. Since a dense stand of poison-bitterweed produces usually a light seed crop, the following season always shows much less infestation. No other annual weed is so perfectly adapted for survival, maintenance, and increase under the ranching conditions found on the Edwards Plateau.

The upper Llano River basin is heavily infested with poison-bitterweed. My first report from Llano County came to me from a ranchwoman, who found some of the plants on her ranch, near the mouth of a creek flowing into the Llano River. To prove her thought that the weed grew more luxuriantly there than it did with us she had carefully counted the heads on a well developed plant, and found more than 2000 of them. As I never had counted the heads on our larger bitterweed plants, her letter stirred me into action. I walked to one of our better lake-beds and selected a vigorous plant. A careful count gave more than 3000 heads. Then I was ready to reply to the letter. As each normal head of the poison-bitterweed contains some 60 achenes, my Edwards County plant could have matured at least 200,000 achenes.

The increase of other native annual weedy forbs on Texas

range lands is attended by similar conditions. That is, depletion or destruction of the grass cover is associated with a source of seed supply of a weed adapted to successfully replacing the depleted grasses. Excellent examples of this situation are shown by various species of *Xanthocephalum*, commonly called "broomweeds." A high proportion of Texas range lands is so infested, and in some parts of the State all of the ranges have one or more species of broomweed. I have seen entire ranges where the cover of broomweed hid the growth of all other herbaceous vegetation. At a time not remote these ranges were all in grass. This general condition is true also where other weedy forbs have become dominant. In one region the dominant weed [of the Spurge family] may be the New Mexico croton, while a few hundred miles away it may be one of the snow-on-the-mountains, also of that family. Various species of the composites may become very abundant, if not dominant, on range land. Such composites are the ragweeds and their kin, the eastern bitterweed, and the woolly groundsel. Of these species, only the woolly groundsel is toxic to livestock.

Various other weeds, poisonous or unpalatable forbs, have increased (mostly within the past 30 years) over the ranching country of Texas. Overstocking of the range that results in the depletion of the grasses and extermination of the palatable forbs, leads to its occupation by weedy plants. At the worst, this condition in time causes ranges once good to become of little or no value for the grazing of livestock. Sentiment favoring improvement of range lands and the maintenance of a good range is now on the ascendancy in Texas ranching country; and it is to be hoped that this sentiment may govern the future prevailing practice.