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Harvesting Pandora Moth Larvae with the Owens Valley Paiute

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THE harvesting of Pandora moth larvae (*Coloradia pandora lindseyi* Barns and Benjamin), or *piagi*, by the Owens Valley Paiute and other native peoples of the Sierra Nevada of California, has attracted varied attention since the turn of the century. Early papers by entomologists, including Aldrich (1912, 1921), Eldredge (1923), Englehardt (1924), Patterson (1929), and Essig (1934), described the basic process, but were based more on hearsay than on direct observation. They thus created some fanciful impressions. Later ethnographic descriptions, such as those by Steward (1933) and Davis (1965), helped sort fact from fancy, although not completely, as they too were based on second-hand information rather than direct observation.

In June, 1981, we observed elderly Paiute from Bishop, California, harvesting and processing Pandora moth larvae. At that time, cost/benefit checks were made on both collection and processing, to which basic nutritional data were added. That season the larvae were collected by hand rather than by the tree-base trenching method that is well attested in the archaeological and ethnographic records. In June, 1982, we planned some additional experiments with the trenching method of collection, in order to compare the basic efficiency of the two techniques. Although unable to complete the experiments because of a population collapse among the larvae, we were able to extrapolate some data from other sources toward these comparisons. This paper focuses on these results, after first describing and illustrating the basic harvesting techniques.

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LIFE CYCLE OF *COLORADIA PANDORA LINDSEYI* (Barns and Benjamin)

The life cycle of the Pandora moth is of specific interest as it sets both the dates and years of harvesting. Basically, it is a two-year cycle, thus making caterpillars available for harvest in large numbers only every other year. It is also a relatively brief harvest period, lasting from 12 to 25 days in late June and early July. In addition, there is also a peaking and collapse of Pandora moth infestations, reported by entomologists as occurring on roughly a 20-to-30-year cycle (Patterson 1929).

The actual life cycle begins with the emergence of adult moths from their pupal cases in early July of the first year. During their short life span (ca. one month), the moths lay a cluster of subspherical eggs in rough, sheltered places in the bark or on the needles of Jeffrey pine (*Pinus jeffreyii*) trees, their principal food plant. On hatching, roughly 30 to 40 days later, the larvae ascend the trees and begin feeding on the needles. This continues for the remainder of the summer. By fall the larvae are in the tops of the trees where they overwinter in clusters of

Fig. 1. Larvae of *Coloradia pandora* on the forest floor, Inyo National Forest, California, 1981.

four to thirty individuals. With the cessation of winter conditions about the first of April, the caterpillars disperse and resume feeding. During the spring, they consume enormous quantities of needles (an average of 21 needles per day per caterpillar [Patterson 1929:15]), and they reach their full size of about 6 to 7 cm. in length. It is during this period in particularly heavy hatch years that defoliation of the trees is most apparent. The high food intake of the *piagi* creates masses of droppings at the base of the trees, a sign used by the Paiute to gauge the caterpillar production of any one tree or area. In heavy caterpillar years, according to entomologist Englehardt (1924:35), "the constant dropping of excrement [makes] a noise like a sleet storm."

In roughly the last week of June or no later than the first week of July, the caterpillars descend the trees in great numbers to pupate in the ground (Fig. 1). It is during this short period of roughly two weeks that harvesting and processing take place. Although the Klamath, Modoc, and Western Mono are reported to have harvested the pupae by sifting the soil and duff at the base of trees (Miller and Hutchinson 1928), the people of Owens Valley and Mono Lake seem to have only occasionally used this method. Once the caterpillars enter the ground to pupate, they remain there through the winter to emerge the following July as adults (Patterson 1929).

Based on this largely biennial life cycle, people could count on a good harvest of Pandora caterpillars only every other year. In the off years, a few stragglers or a small hatch might occur in selected areas. However, few

Fig. 2. Circular trench around Jeffrey pine tree, dug to contain larvae as they descend tree to pupate in the ground. Last used in 1979. Photo taken in 1982.

individuals apparently considered these harvests worthwhile, and the caterpillars were generally ignored. The focus of attention was the peak production period, from the end of June through early July. Then the people of Owens Valley and Mono Lake removed themselves in family groups to the harvesting areas in the Jeffrey pine forests between the headwaters of the Owens River and Mono Lake.[1]

HARVESTING AND PROCESSING, 1981

Caterpillars are ordinarily collected in trenches (*odiabi*) dug around the bases of trees selected for their accumulations of caterpillar frass (Fig. 2). According to the elders, old trenches were cleaned and new ones dug when the people first arrived at the harvesting grounds. Old trenches take a person roughly ten minutes to clean, "if you get right at it." The trenches were approximately one-third meter deep and roughly one-third to one-half meter from the tree, and totally encircled it. Cleaning takes the trenches to the level of the old soil or just below. All litter such as pine needles and twigs, as well as other debris, was removed. The elders noted that trenches had either vertical or back-cut walls to prevent the caterpillars from climbing out.

New trenches were made in the same manner, being excavated roughly one-third to one-half meter from the base of the tree, and roughly one-third meter wide and one-third meter deep. In former times, a wooden digging stick (*woobi*) was used for excavating the trenches. New trenches were placed around trees that showed an accumulation of caterpillar frass or other obvious caterpillar

Fig. 3. Mrs. Minnie Williams collecting larvae from the ground with a stick and bucket, 1981.

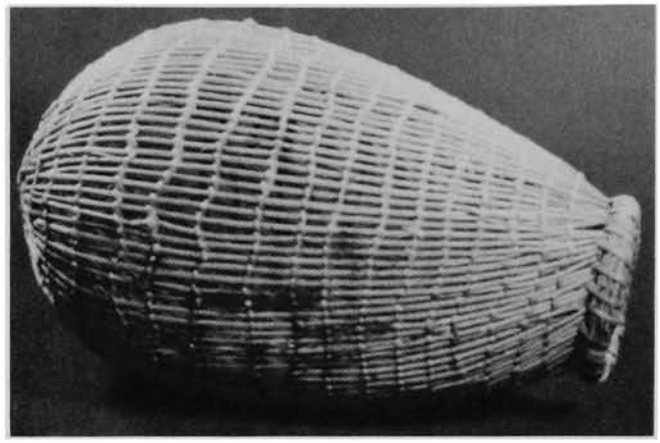

Fig. 4. Open, plain-twined basket used to collect and store *piagi*. Collected by J. W. H. Hudson, Long Valley, California, 1904. Field Museum of Natural History, No. 59029. 40 cm. in length.

Fig. 5. Caterpillars being mixed with hot sand in circular roasting pit, 1981.

Fig. 6. Removing caterpillars from roasting pit to fan-shaped hardware-cloth sifter, 1981. In former times, an open, plain-twined winnowing basket was used.

activity. The only social restriction placed on excavation of new trenches was that they must be located in one's own family area. Trenches were private property, usually inherited through the female line.

None of the Owens Valley elders felt that building fires around the bases of trees, as reported by entomologist Aldrich (1912) as well as by Steward (1933: 256) and by Davis (1965), to smoke the caterpillars would necessarily bring them down faster. "They come down on their own," the elders said, and indeed in June, 1981, they were observed descending the trees in large numbers.

Trenches were cleaned of caterpillars twice daily and processing took place coincidently. During the 1981 harvest, caterpillars were merely gathered from the ground at a rate of roughly 100 per 30 minutes (Fig. 3). In the past, the caterpillars were kept in the shade in open-twined globular baskets (Fig. 4) or in a "large pit" (Warren 1963) while awaiting processing. Today, plastic buckets serve as well, as the caterpillars are prevented from climbing out by the slick sides.

Processing begins in a sandy area with the construction of a roasting pit about one meter in diameter. In the past, larger pits may have been used depending on the catch. A conical mound of sand is first made and then hol-

Fig. 7. Sorting washed, roasted caterpillars in preparation for boiling, 1981.

lowed in the center. A fire is built to heat the surrounding sand. The coals are removed and the live caterpillars are then placed in the hollowed center of the pit (Fig. 5). They are mixed with the hot sand at the bottom of the pit, covered, and left to roast for 30 minutes to one hour, depending on what additional processing is planned.

After roasting, the caterpillars are removed from the pit and sifted to remove the sand. An open-twined parching basket (*paco*) was formerly used, now replaced by the ingenious device of willow, reinforcing rod, and hardware cloth shown in Figure 6. The roasted caterpillars are then washed and sorted. Any "flat" (possibly diseased), overcooked, or discolored caterpillars are discarded in favor of nice, plump, yellow ones (Fig. 7). *Piagi* to be eaten immediately are boiled for roughly one hour in either salted or unsalted water, depending on individual taste. Boiled caterpillars are taken from the water and their heads removed. The results are enjoyed by all (Fig. 8). Caterpillars are eaten plain or made into a stew with other meat and/or vegetable products. The skins of the caterpillars are rather tough and they retain their shape when cooked.

Caterpillars to be dried for storage are placed in the shade for two or three days to two weeks. In former times, pole-and-bark drying sheds were used, at least in some areas. According to the elders, if the caterpillars are sun-dried they will rapidly become rancid. In the opinion of one individual, caterpillars boiled in salted water also would taste "old" by next spring. Dried caterpillars were stored in a "cool place," sometimes being cached at

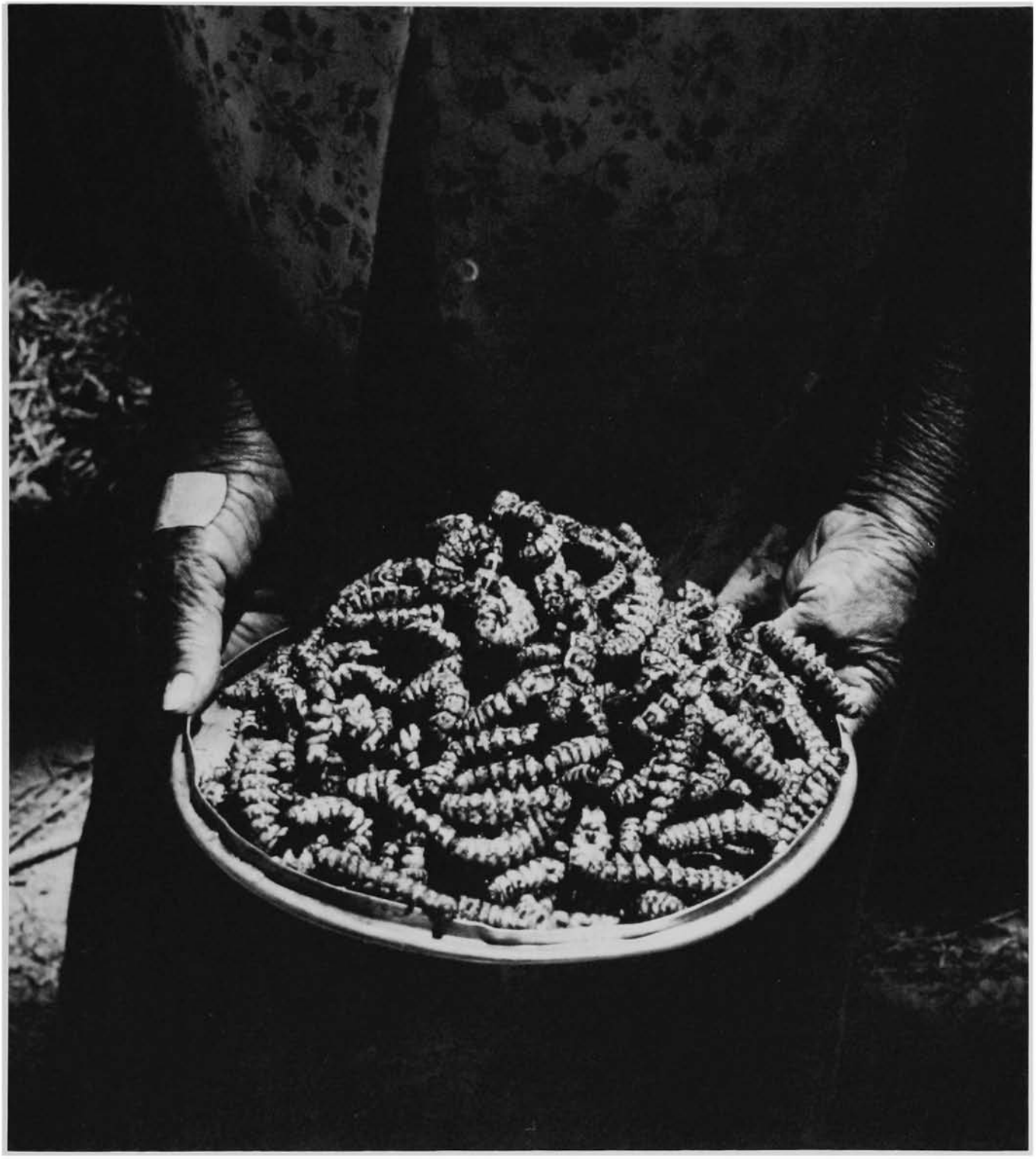

Fig. 8. Plate of boiled caterpillars, ready to eat, 1981.

the harvesting grounds in the pole-and-bark sheds or in pits. They kept well through the winter, and with care into the spring and early summer.

NUTRITIONAL DATA

It was reported by Aldrich (1921: 36-37) that Chief Jake Garrison of Mono Lake put

up one and one-half tons of *piagi* during the summer of 1920. Given the nutritional data (Table 1), such a quantity would result in a considerable amount of fat, protein, and carbohydrates.

The protein content of *paigi* (11.78%) is from twice to three times that reported for most Owens Valley plant foods; e.g., *Balsamhoriza, Calochortus, Perideridia, Wyethia* spp. (Yanovsky and Kingsbury 1938). However, the fat content (10.94%) is roughly one-half, and the carbohydrates (4.33%) less than one tenth that of pinyon nuts (*Pinus monophylla*) (Farris 1982: 119). But rough estimates of calories/hour returned for collecting and processing caterpillars are nearly twice those of pinyon nuts and considerably above those for most plant foods studied by Simms (1984: 86).

EFFICIENCY OF HARVESTING TECHNIQUES

Given the short harvesting period, processing Pandora caterpillars was probably well worth the effort. But, just what was that effort and how efficient and effective were the techniques developed by the people to lessen its impacts? We had hoped to answer this question with substantive field studies in the 1982 season, focusing on the comparative value of collecting caterpillars in trenches *vs.* gathering them individually as we did in 1981. We reasoned that trenching must offer some advantage, but what was the advantage and how could it be measured? Unfortunately, the 1982 season proved to be an unusually poor year for a mid-cycle caterpillar hatch. We had hoped for some good isolated local hatches upon which to base our harvesting comparisons. However, very little evidence of caterpillars was found, and subsequent years from 1982 to the present (1985) have shown that a predicted population collapse, the down side of the roughly 20-to-30-year peaking cycle, is in effect.

Lacking the possibility of deriving data experimentally, we turned to verbal and written accounts of harvesting totals for some comparative figures. From one of the Owens Valley elders, who had collected caterpillars by the trench method in 1979, we learned that by working five or six trees at the normal rate of two times a day over a weekend, he had gathered roughly 25 pounds of caterpillars. Assuming that the 25 pounds represented live weight, and given that this individual prefers to process his caterpillars in the fine sand of his backyard in Bishop, mathematical extrapolation indicates he removed roughly 100 caterpillars from each trench at each collection time. This is the same individual who stated that it took roughly ten minutes to clean each of the old trenches when he arrived at the site (about one hour of work total).

In 1963, Dick Warren of the U. S. Forest Service observed three members of a family gathering *piagi* two miles northeast of Bald Mountain. The family was working 18 Jeffrey pines, collecting the caterpillars twice daily.

Table 1

NUTRITIONAL ANALYSIS[a]
COLORADIA PANDORA LINDSEYI

Moisture	71.82%
Total Protein	11.78%
Fat (Ether extract)	10.94%
Ash	1.13%
Carbohydrates	4.33%
Calories/100 g.	163.
Calories/oz.	46.
Calories/Hour worked	1,840-2,753[b]

[a] Nutritional data arc based on 100-g. sample, roasted, washed, boiled with non-iodized salt, MICHELSON LABORATORIES, Los Angeles.

[b] These figures are based on estimated 10-hour day (4 to 6 hrs. collecting and 4 hrs. processing) and yields extrapolated from reports given in this paper (hand-collecting trial, 1981: 2,753 cal./hr.; two reports of trenching yielding 25 lbs./2 days for 1,840 cal./hr. and 250 lbs./wk. for 2,628 cal./hr. All are probably low).

Warren (1963) stated that "some trees produced over one hundred larvae" on the collections in which he participated. This is the approximate figure calculated for the Owens Valley collector. If that yield continued for roughly one week, the family would have collected over 250 pounds cooked or 100 pounds dry weight in caterpillars.

In addition, as previously noted, we also had the account published by Aldrich (1921) based on data from another forester, Guy Way, that Jake Garrison and his group collected and cured one and one-half tons of caterpillars in the 1920 season. This seems like a very high figure given the yields suggested in the two previous accounts. However, from an account given by Way and quoted by Miller and Hutchinson (1928), we learned that Mr. Garrison's camp was a large one, that he assigned certain families areas in which to harvest, and that the women not only cleaned the trenches of caterpillars but also picked them off tree trunks, while back in camp processing "was in full swing" (Miller and Hutchinson 1928: 160).[2] Given that the harvest could have lasted a maximum of three weeks, Mr. Garrison's groups would have to have worked 50 trees to have obtained the weight in cooked caterpillars and more than twice that to have obtained the dry weight. However, if this were a multi-family operation, that weight could quite easily have been obtained by five to seven families working 20 trees each.

But, could comparable yields be achieved by merely harvesting caterpillars from the ground and from tree trunks as was done in the 1981 season? Without doubt they could, at least up to a point. One person collecting caterpillars for the roughly four to six hours per day that the caterpillars are active could collect about 1,000 per day – the minimum yield of five trenched trees. Three harvesters could come close to the yield of the family observed by Warren (1963).

What, then, are the advantages of trenching and why did this method develop? The most obvious advantage of this method of collection is that it leaves most of the camp members free to process caterpillars and/or collect additional *piagɨ* by hand. The overall harvest period is at maximum three weeks long, and time is thus important. Processing (twice daily) takes a total of roughly four hours. The site must be cleaned and cleared, wood collected, the fire tended, the caterpillars sifted and stored, spread to dry, and so forth. The work is not particularly energy consuming but it is time consuming. It is doubtful that much could be done to reduce processing time without altering the social pattern of family-based collecting.

Caterpillars are ordinarily processed in small batches by family members. Increasing the batch size would require additional personnel – not an obvious saving. The produce of a small number of trees, collected twice each day may be about what a fairly small, family-based unit can handle at a regular pace. But, savings can be made in collecting time by taking proper advantage of the caterpillar's habits. *Piagɨ* descend the trees to pupate, they *will* collect in the trenches and, if the trenches are properly constructed, they *will* remain there. The human collectors are thus free to augment the catch with individuals picked up from the ground or to help with processing. The trenches, in effect, serve as additional collecting personnel.[3]

The other advantage of the trenching method of collection is more subtle, but perhaps no less important. Paiute linguistics provides the clue. Caterpillar trenches are called *odɨabɨ*, from the stem *tɨa-*, "to cache." Caterpillars are a fragile commodity. Once collected, they must be kept from the heat and spared overcrowding or they will die. Dead caterpillars are not worth processing. Caterpillars in trenches are in the shade of the trees. Given that the trenches are circular, the

caterpillars will keep moving around the tree searching for an exit. They will also attempt to pupate immediately in the forest soil unless prevented from doing so. The cleaned sidewalls and bottom of the trench prevent this. Trenches are thus also functioning as "caches" of living resources awaiting processing.

ANTIQUITY OF *PIAGɨ* EXPLOITATION

Little is known of the antiquity of collecting *piagɨ* by the Owens Valley and Mono Lake Paiute. Even less is known of the antiquity of collecting them by trenching trees. According to Forest Service survey data, there are over 4,000 trenches in the Inyo Jeffrey pine forests (Richard Weaver, personal communication 1985; Weaver and Basgall MS). Older sites visited in 1982 are known to date to before the turn of the century. However, trenches rather quickly fill with forest litter and become all but invisible after roughly 60 to 100 years.

The term *piagɨ* is also of interest, as it appears to be an old form in the northern Uto-Aztecan languages for some type of larvae. It has cognates in the Numic languages, in Cahuilla (*piyaxat*, "worm with two horns" [Seiler and Hioki 1979]), in Tübatulabal (*pi?agɨn-t*, "grub worm" [Voegelin 1958]), and in Hopi (*pi?akɨ*, "corn worm" [Voegelin 1957]). It is tempting to suggest that the original referent for these cognates was *Coloradia pandora lindseyi*, and thus that *piagɨ* have been harvested for many centuries. But, it is equally likely that the referent was the white-lined sphinx moth larvae (*Hyles lineata*; see also Fenenga and Fisher 1978 for this identification of the Cahuilla referent). These larvae were much more widespread and also commonly collected by most northern Uto-Aztecan groups.

Although few conclusions can be reached as to the antiquity of the use of *piagɨ* and the techniques presently employed to take and process them, we have been able to offer better documentation of practices through contemporary observation. Perhaps additional work with the elders of Owens Valley, in addition to archaeological investigations (e.g., Weaver and Basgall n.d.), will provide more definitive conclusions in the future.

NOTES

1. Archaeologically, trenches are also known from south of Lookout Mountain, northeast of Mammoth Lakes, California (Richard Weaver, personal communication 1985). But contemporary gathering takes place considerably north of this locality.

2. Way's two accounts (Way 1920; Miller and Hutchinson 1928) are slightly at variance. In one (Way 1920), he stated that men collected the caterpillars from the trenches and women transported them to the processing site. After all were transported, processing took place. But Way was also quoted by Miller and Hutchinson (1928: 159-160) as saying that the women did most of the collecting, carrying burden baskets filled with larvae to camp where processing "was in full swing."

3. Although we lack data on time required to clean caterpillars from trenches, we suggest that it is roughly half to one-quarter that required to pick up caterpillars by hand from the ground and/or off trees.

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