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H. Nelson Elliott
U. S. Bureau of Sport Fisheries and Wildlife, Portland, Oregon

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Regional Supervisor of Predator and Rodent Control
U. S. Bureau of Sport Fisheries and Wildlife, Portland, Oregon

As is the case in many sections of the country today, starlings are causing increasing concern in the Pacific Northwest.

When these birds were first recognized in Washington, Oregon and Idaho in the early 1940's only small numbers were seen, usually with blackbirds. During the 50's, however, the number of wintering starlings increased from a few birds, to thousands, with estimated flocks of 25,000 to 50,000 in western Oregon and along the Snake River Valley in Idaho and eastern Oregon. During the past five years winter resident populations in these areas have been estimated by the 100,000's, with some observers estimating roosting concentrations as high as several million.

Damage due to winter roosting of enormous numbers of starlings in western Oregon holly orchards and increasingly severe losses to cattle feedlot operations through consumption and contamination of feed resulted in the development in 1959 of a pilot program between the Oregon State Department of Agriculture and the Bureau of Sport Fisheries and Wildlife designed to develop effective, safe and economical methods of starling control. This initial investigational work which began in November 1959 and terminated for the season March 20, 1960 consisted of testing frightening devices and a floodlight trap in the holly orchards and tests with lethal bait and live traps around the feedlots.

Because of increasing damage to an expanding livestock feeding industry in Idaho the 1960-61 phase of the program was extended to include more extensive experiments with lethal agents both in Idaho and Oregon. The program was converted to a two-unit cooperative research project under leadership of the Denver Wildlife Research Center, made possible through financial participation of the Idaho Cattle Feeders Association and the State Department of Agriculture.

During the 1960-61 season cooperative efforts in developing methods to control starling damage to fruit were also initiated in eastern Washington, through action of the Washington State Fruit Commission, with financial support by the soft fruit industry and livestock feeders. These efforts were augmented during the next session of the State Legislature by action classifying starlings as predatory birds and authorizing expenditure of State Department of Agriculture funds specifically for starling control. Because of manpower I imitations and prevailing circumstances in the Yakima Valley, activities in Washington were limited to live-trapping experiments and banding, which was not included as a formal work unit of the research project.

Also not a formal unit of the research project and although perhaps somewhat repetitious, it was determined in 1960 that a survey of nesting behavior, food habits and productivity, of the starling in typical summer habitat would contribute useful data in attempting to develop control techniques. This survey, which was conducted in two western Idaho counties, contributes information that we believe may be typical throughout nesting habitat in Idaho,

western Montana, Washington and Oregon, east of the Cascade Range, which includes major fruit producing districts in the Pacific Northwest.

The main portion of the nests are built in natural cavities in trees and cavities excavated by woodpeckers. Similar cavities and other suitable nest sites are found also in abandoned and inhabited buildings throughout rural areas, as well as in the cities. There is also evidence of increasing nesting activity in crevices along canyon walls in the middle Columbia basin.

Several species of trees seem to be preferred as nesting sites; probably because of woodpecker preference and the frequency of natural cavities. Box elder, cottonwood, willow, Rocky Mountain maple, Lombardy poplar and apple, in that order, are the most frequently used.

Starlings in Ada and Canyon counties of Idaho may raise three broods annually, averaging five each. The majority of starlings laid their first clutch of eggs from April4 to 14 and by May 14 the main portion of the first brood had left the nest. By June 26 the second broods had left their nests. The third clutches, in the main, were laid during the last five days of June and by the end of July the third broods had left the nests.

The food of the young is almost identical to that of the adults. Insects and earthworms are the main items in the diet, but cherries and a variety of berries are also fed to the young while in the nest. Both parents attend the young in the nest, and while from one to seventeen days of age, one or the other of the adults visit the nests to feed the young on an average of once every five minutes. (Subsequent observations in the Yakima Valley, Washington reveal that orphaned broods may be regularly raised by other adults in the nest area, indicating a strong reproductive urge).

Information on food habits through stomach analysis and extensive field observations in other sections of the country have also demonstrated conclusively that these otherwise insectivorous birds inflict damage to cherries, other small fruit, and even late fruit and corn.

Juvenile birds from the first and second broods, from the same as well as other families, group together into flocks of ten to a hundred or more. Such juvenile flocks are the birds responsible for damage to fruit, the degree of which will, of course, be governed by the density of the breeding population. In view of the over-all increase in starlings and expansion of nesting range in recent years, it is safe to say they are now a serious economic pest in many fruit producing areas and have the potential of becoming a greater pest problem.

In discussing methods under study we wish to emphasize that bird control is a comparatively new field to us and although some experiments appear encouraging under certain Northwest conditions, at this point, much remains to be accomplished. Therefore, our findings should not be construed as recommendations that may be applied operationally in other areas.

Frightening Devices

Amplified starling distress calls and acetylene exploders were evaluated in holly groves in the Willamette Valley. In all tests it was found that starlings could be frightened from holly groves with the amplified distress call and acetylene exploder. However, numerous limitations were encountered with both devices and in all tests it was found that men on foot are necessary for complete success.

A combination of acetylene exploders and amplified distress calls was used very effectively to remove roosting starlings from a holly farm near Carver, Oregon. This eighty-acre holly grove, which measures about 600 feet wide and 4,000 feet long, harbored up to about 200,000 roosting starlings. Seven acetylene exploders, timed to explode at about one minute intervals, were set up in and around the grove. At the same time two "WE-A6" audio units, mounted on revolving platforms, were placed about 2,000 feet apart midway in the grove.

The equipment was started at the time starlings began to arrive in the evening and was continued as long as they attempted to come in. Men on foot would patrol a portion of the grove, beating sticks together and firing an occasional cracker shell into the milling masses of birds overhead. It was found necessary to have at least four men, in addition to the frightening devices, to prevent the birds from coming into sections of this eighty-acre grove. Three or four consecutive nights of operation were sufficient to cause the birds to move elsewhere. However, the respite was usually of short duration, as the birds would begin to return in ten days to two weeks.

This combination can effectively move roosting starlings from holly groves. However, in most cases, it merely compounds the problem by moving the birds into other groves nearby. Noise making frightening devices are also very often objectionable where holly groves are adjacent to suburban areas. One holly grower effectively frightened the starlings from his ten acre grove with two acetylene exploders; however, their poultry-growing neighbor threatened with a law suit unless their use was discontinued, because of adverse effect on egg production.

The Light Trap

During January 1960 a light-trap was constructed and placed in operation near Monmouth, Oregon.

This trap was designed from the plan provided by the Patuxent Wildlife Research Center. Basically, it consists of a large net funnel leading into a wire cage. The leading edge was sixty feet wide, supported by two forty-foot masts. The funnel, approximately 45 feet deep, slopes from the top, tapering into a 10' x 8' x 8^1 wire cage. Approximately 28 feet back from the leading edge, two twenty-foot masts are erected to help support the No. 6 thread, 2-1/2 inch stretch mesh nylon net.

Behind., the 10' x 8^1 x 8' cage is a battery of five, 1,000 watt flood lights supported by an "A" frame, approximately two feet above the ground.; The opening of the funnel faces the roost about 30 feet from the first row of holly trees. These trees, thirty years old, were 25 to 30 feet in height.

The trap is operated by driving the birds toward the open end of the funnel with the flood lights turned on. The birds, attracted by the light, fly into the funnel and thence into the wire cage. The manner of driving the birds will be determined by their reaction. In some cases, salutes, shot guns, or other noise makers, may be necessary to disturb the birds, while on other occasions just yelling and walking along will herd the birds. It is critically important that drivers be well coordinated so the birds are gradually herded into the area immediately in front of the funnel entrance. No one should stand where they are visible in the lights during the drive.

After removing live starlings for banding the remaining birds were quickly destroyed by introducing cyonogas or hydrogen sulphide gas into the catch cage which was covered with canvas. For safety reasons the dead birds were then allowed to remain in the catch cage over night.

The light trap was operated at the Monmouth location on ten nights each, during two consecutive seasons, 1960-61 and 1961-62. The respective seasonal catches were 31,466 and 46,575 starlings. Although the catch was increased during the 1961-62 season, perhaps due to improvements in the trap, it amounted to only about 10% of the estimated roosting population.

Although impracticable as a method of reducing roosting populations of starlings in Oregon holly groves, the light trap did contribute useful information on the roost composition and provided a reliable source of birds for banding.

While trapping the 78,041 starlings during 1960-61 and 1961-62 seasons near Monmouth, only 502 birds of other species were caught; of these 353 were redwing blackbirds, 112 robins, 18 Audubon's warblers, 18 cowbirds and English sparrow.

During the 1962-63 season the light trap was moved to a holly grove on the outskirts of Portland where 39,177 starlings were trapped in eleven nights from a roost containing an estimated 1,000,000 birds.

Lethal Baits

With the specific purpose of investigating, developing and testing safe techniques for the reductional control of starlings, this segment of the coordinated program was conducted from November 14, 1960 through March 25, 1961 at a Caldwell, Idaho cattle feed yard. The scope of the program included testing of various toxicants and formulations through confined cage experiments with live birds, and the analysis of related field tests.

During the course of the 1960-61 Pen Studies many different toxicants were applied to food and tested. In each test equal amounts of untreated food and poison-treated food were placed in separate containers and exposed to a separate set of test starlings, (25) in pens measuring 9' x 9' x 6'. The food used in the experiments was reject French-fried potatoes, which is a constituent of the cattle ration at many cattle feedlots throughout Idaho. This product is inexpensive and starlings show a definite preference for this material.

A summary of the data accumulated throughout the entire season (1960-61) indicated that thallium sulphate applied to potatoes was the most efficient starling control toxicant tested. The data also indicated that a concentration of thallium sulphate as low as 1 to 400 parts, or 0.25 per cent, was sufficient to kill 100 per cent of the test birds in four separate tests, and was considered to be the optimum concentration.

An attempt was made to dilute thallium with water to desired concentrations. It was apparent that only a small amount of thallium sulphate was suspended in the hot water (212°F.). Therefore, very high concentrations were required to obtain good kills. Dipping the food in warm water affected the French-fries by removing the grease coating; thus decreasing attractiveness to starlings. Treatment by sprinkling thallium sulphate powder over the potato bait appeared to be the most efficient method.

During the first season no information was obtained relating to the exact period of time elapsing between bait exposure and mortality. But observations indicated that all mortalities occurred between nine and twenty-two hours after bait exposure. Regurgitation did not occur after starlings had ingested thallium, as it did with several other compounds tested. The test birds did not appear to detect the presence of thallium on the food and readily fed on it when untreated food was also present.

A study with thallium killed birds being fed to cats was conducted to determine if secondary poisoning was a related hazard. A total of 12 skinned birds killed with twenty times the optimum concentration of thallium was fed to each test cat for six successive days, with no noticeable effects. The birds used were average size or about 65 grams per skinned bird. The test cats were not weighed but were in the small to medium class or about two pounds.

Since facilities to record the exact amount of thallium retained by the test birds were not available and the exact amount of bird-flesh consumed by the cats was not recorded, the concentration of thallium ingested by the cats was not known. Therefore, due to cumulative effect of thallium sulphate this data would not be entirely valid, although it might indicate a minimal secondary hazard when using one-twentieth of this concentration in starling control.

At the end of the 1960-61 seasons (March *24*, 1961), it was concluded that additional studies should be conducted to determine the hazards that may exist. Information concerning the exact time required for death after different concentrations of thallium treated food had been consumed was desired also.

In the Northwest the majority of starling wintering populations concentrate in large numbers within small areas to roost. If a proper concentration of thallium could be calculated to kill 95-100 per cent of the pen-test birds during the night roosting period of from 13 to 15 hours, it would appear that secondary hazards, if any, would be minimized when used under field conditions. Therefore, the birds killed under field tests would be concentrated in the roosting areas, which in most cases are removed from the metropolitan areas in Idaho and eastern Oregon. In fact these roosts are so isolated that **the** possibility of secondary poisoning in either wild or domestic animals **does not** appear to be a major problem.

In January 1962 controlled pen experiments were resumed, in relation to 1960-61 determinations, at Deer Flat National Wildlife Refuge near Nampa, Idaho.

In most experiments per cent kills were read at 8, 10, 12, 14, 24 and 48 hours after treated food exposure. Each experiment involved the use of 10 test birds exposed 8-9 hours to equal amounts of treated and untreated French-fried potatoes. The presence of treated and untreated foods was to simulate field conditions as much as possible. The survivors of initial 8 to 9 hours exposure (normal feeding day), and the following normal roosting period of 13 to 15 hours, were held on untreated food for an additional 24 hours. As a control, ten birds, fed on equal quantity of clean food were used with each test to determine the natural mortality, if any.

A problem was encountered in spreading evenly minute quantities of thallium over large amounts of food. An example, for instance, was the uniform distribution of 600 grams of thallium over 400-500 pounds of food. This problem was solved through the use of a spreading agent such as powdered sugar, talc or gypsum. Powdered sugar appears to be the best spreading agent of those tested.

A better method of food treatment was developed than the 1960-61 technique of sprinkling the thallium over the French-fries which were spread over a table. Instead, the bait to be treated was placed in a one-gallon jar with the measured amount of thallium and spreading agent, and shaken until thoroughly mixed.

Results revealed that thallium sulphate at 1 to 400 parts, with powdered sugar as the spreading agent, was the most efficient concentration of those tested. This concentration produced a 97% kill of test birds between 6 to 14 hours after initial food exposure. The remaining three per cent were dead at an additional check 22 hours after exposure, which indicates that if this test had been conducted under field conditions, the vast majority of the birds ingesting the thallium treated food (1:400) would have died on their roost between 6 to 22 hours after food ingestion. These test birds consumed almost as much untreated food (5.4 grams per bird), as they did treated food (6 grams per bird), which points out the minute amount of thallium lethal to starlings. The fact that untreated and treated food was consumed in almost equal quantity, indicates that no detection of thallium was made. Presence of treated and untreated food apparently simulates field conditions because starlings in the wild around select Idaho and eastern Oregon feedlots will have fed on clean food in various amounts before feeding on treated food.

From 2/23/62 through 3/28/62 a series of Field Tests with thallium sulphate were conducted at feedlots near Caldwell, Idaho and Ontario, Oregon. The purpose of these tests was to evaluate the efficiency of thallium sulphate (1:400 parts) under field conditions. All tests were conducted with 5 grams of powdered sugar per 0.25 grams of thallium sulphate. Sugar also appeared to increase preference for the treated food.

At the beginning of these tests the bait was mixed by hand in 30-gallon shortening tins but since this was slow and required too much labor, a one-half yard electric powered concrete mixer was used. It was discovered that one man could treat from 300 to 400 pounds of bait in an hour, efficiently and safely, with the mixer. The pre-mixed thallium sulphate sugar mixture

was placed on the moving French-fries in the mixer, a large spoonful at a time. Respirator, rubber clothes, and gloves, were worn by the person treating the bait.

At the Ontario lot the treated bait was placed on eight piles of prebait eight feet in diameter, containing about 1,600 pounds of prebait. At Caldwell a single or double windrow of French-fries 200 feet long and 4 feet wide, containing approximately 3 to 4 tons of prebait, was used.

The exact location of the starling roosts were known and sample plots or quadrats for subsequent kill analysis were set up before field tests started.

Dead birds in the plots were counted each day following the tests. The Oregon roost located on a Snake River island, two miles northeast of Nyssa, contained 117,000 square feet. All open, denuded areas, were not included in the total roosting area. To be conservative in kill estimates, all outlying or scattered trees where deaths did occur were not included as roosting areas.

The Idaho roosts were located on two islands and the mainland shore, four miles up the Snake River from Homedale, and a roost three miles west of Roswell. The over-all surface area of the Idaho roosts was 334,950 square feet. Again, outlying trees, of which there were many, and open areas, were not included in the surface figure.

During the 21 day period of field testing with 3,200 pounds of bait, an estimated total of 245,600 starlings was killed at the two test sites, which means an average of 11,695 birds were killed each day. This is an over-all average of 76.7 birds killed per pound of bait.

Secondary Poisoning

After two seasons of large scale field testing no observations were made concerning Secondary Poisoning of wild or domestic animals. Close contact was maintained with farmers in the vicinity of the Idaho mainland roost. Together these farmers owned 30-40 cats and 15-20 dogs which could come in contact with dead starlings. The island roosts, of course, are not visited by the dogs or cats. On one occasion 28 dead starlings were moved from the mainland roost to one farmer's yard by his German shorthair pup. When told that the birds were poisoned this farmer was unconcerned.

A resident in the city of Caldwell, Idaho reported 32 dead starlings under a cedar tree in their yard on March 19, 1962 that probably had died of thallium poisoning. These birds, no doubt, had established this small roost during the warming spring weather. However, during the cold winter months these small scattered roosts are practically non-existent.

Veterinarians and county agents were contacted in test areas, and newspaper articles informed the public of activities. Considerable effort was devoted to observing possible killing of mammals, hawks, owls, and other birds in and around roosting areas. None were found, although as many as 40 to 50 magpies were observed feeding on dead starlings at one time.

Large Scale Field Testing of thallium was continued during the winter of 1962-63 and again this year, based on the information obtained during the previous seasons.

A total of eight rather large feedlots in Idaho and Oregon were selected as test sites. The tests were conducted from 10/10/62 through 3/21/63 although actual bait exposures were made only on 44 separate days. An estimated total of 1,227,300 starlings was eliminated with 16,175 pounds of bait (1:400 thallium treated French-fried potatoes) at the eight feedlots during the 132-day test period. However, the estimated number of starlings killed is not as important as the fact that control was obtained at every feedlot where bait was exposed.

The earlier tests in Idaho during October and November were extremely effective because of above average amount of precipitation, mostly in the form of snow, and the number of day when the temperature was below freezing, which tend to force starlings into the feedlots where they feed abnormally heavy.

Baiting Stations and Baiting Procedure

Baiting sites at the feedlots in Idaho were located at a distance of several hundred yards to about one mile from the feedlot. Since it is the nature of starlings to congregate in large flocks, this baiting procedure concentrated the birds in one or two locations, thus improving bait consumption. Watering places were also near the bait stations, so the birds possessed all the requirements necessary to them without having to enter the feedlot. Hazing could then be initiated in the feedlot to facilitate the concentration of starlings at the baiting sites.

Feedlot hazing was accomplished by firing shot-gun shells, cracker shells, automatic exploders, amplified starling distress-calls, and by using TEPP-treated French-fries. On several occasions 1.0 per cent TEPP-treated potatoes, scattered lightly in feedlot alley-ways, killed several hundred birds, and its characteristic repellency forced the remaining birds to the thallium baiting areas. TEPP was not used at the thallium baiting areas because bait shyness usually develops, as was demonstrated at Caldwell in 1960 and 1961.

It was observed that starling live traps placed near the baiting sites proved to be excellent decoys. The live birds in these traps appeared to attract and hold more starlings at these sites.

The baiting stations were pre-baited with fresh reject French-fried potatoes until starlings were feeding heavily. The thallium treated potatoes were then placed on top of the pre-bait in quantities which were judged to be proportional to the existing starling population, but enough pre-bait was left beneath the treated portion to hold the birds at the baiting station for at least the remainder of the day on which the treated bait was placed.

The baiting areas were posted with poison warning signs to prevent human interference and the baits were covered with canvas or plastic to prevent night feeding by waterfowl. Additional precautions were taken at Caldwell to protect waterfowl which are vulnerable in the Boise and Snake River Valley. A special power line was installed at the baiting site to operate a thousand-

watt rotating duck light, these devices have been observed to be very effective in hazing ducks at night.

After two or three days had elapsed following each treated bait placement, the remaining treated bait and pre-bait was destroyed by deep burial. The residual of thallium makes this operation an important phase of this baiting technique. However, in nearly all instances both the pre-bait and treated bait were completely consumed by starlings in two or three day's time.

Live Traps

Although live traps have been used in conjunction with the eastern Oregon-Idaho studies, this approach was selected for extensive evaluation as a fruit damage control technique in eastern Washington. One man, a former cherry grower familiar with bird damage problems in the Yakima Valley, was employed in January 1961 to work full time under the Bureau's Branch of Predator and Rodent Control supervisor stationed at Yakima on this program segment.

Unlike the Idaho and Oregon seasonal studies, the Washington trapping has been conducted throughout the year. During the spring and summer efforts have been concentrated in cherry producing districts.

Initially six traps, 6' x 8^{1} x 6', were constructed. With these as models, fruit growers were urged to obtain their own traps and to place them in operation. In assisting to accomplish greater use of the traps by individual fruit growers excellent publicity was provided by the "Good Fruit Grower", a bi-weekly trade journal published in Yakima, daily newspapers, radio and television stations, and the Extension Service. Several lumber yards stocked and sold traps, either as finished units or in kit-form, complete with assembling directions.

The Bureau employees assisted interested fruit growers in selecting locations for their traps, provided necessary live decoy starlings and in some instances arranged for necessary trap bait. This approach soon resulted in a route type daily operation covering some forty miles. By the end of June 86 traps were in operation in the Yakima Valley and more than 15,000 starlings had been trapped.

In the daily servicing of the traps, it was noted that a small percentage of the trapped birds escaped through the entrances. A variety of new trap entrances were tried. The entrance found most effective is made of 1/2 inch exterior plywood, 8' x 16", containing three entrance slots, 24" x 1-3A", spaced nine inches from both ends and three inches apart. Various modification tests of the plywood panel entrances have demonstrated that the dimensions of the entrance slots are quite critical.

Knowledge gained during the past two years of local habits of starlings is perhaps the most important accomplishment to-date.

In the spring of 1962, there were several areas where damage to cherries occurred and regardless of efforts little protection was evident once the starlings had started on an orchard. This situation directed attention to locate the source of the starlings causing the damage. The first accomplishment

was the locating of so-called prime nesting areas. Although the starlings are widely scattered during nesting season in eastern Washington, there are certain areas where nesting is concentrated. Traps located in the prime nesting areas during April and May will take a few adult starlings and the catch will pickup significantly as the young birds come off the nests.

Further observations revealed that family groups or larger numbers of young starlings spend time in open pasture land usually adjacent to nesting sites; presumably where the adults teach them to forage for themselves. Traps were also effective at such locations. The young birds are easily attracted to the traps containing live decoys.

During the spring and summer of 1963 entire flocks of juvenile starlings were eliminated in a short period of time; often one or two days.

Observations also revealed that starlings follow regular local flyways and that traps set in line with these consistently produce larger catches. When possible traps are placed on high, open ground along these flyways.

Over 100 traps in service during 1963 practically eliminated starling damage to the Yakima Valley 90,000 ton cherry crop.

Through December 1963 over 110,000 starlings have been removed from eastern Washington fruit producing districts.

Banding

To learn more about seasonal and local movements of starlings systematic banding has been conducted in conjunction with all segments of the pilot-program. Approximately 25,000 starlings have been banded of the 268,211 birds trapped. Band returns reveal a general north-south movement of a large segment of population wintering in the Northwest. Starlings banded in western Oregon, Caldwell, Idaho and Yakima, Washington, have been recovered during the nesting season in British Columbia, Alberta and Saskatchewan.

Summary

Although roosting starlings can be moved from one holly grove to another through the use of acetylene exploders and amplified distress-calls, supplemented by men on foot, this procedure offers little value in preventing damage to holly in the Northwest.

Use of the floodlight traps is of no value as a holly damage control method under prevailing conditions in western Oregon.

Although damage control by wintering starling populations at select cattle feed yards in Idaho and eastern Oregon has been accomplished through large scale field tests during the past two seasons, the use of thallium by the Bureau of Sport Fisheries and Wildlife will remain on a research basis for an indefinite period pending additional data.

It is anticipated that little further research on thallium will be undertaken but that further emphasis will be on the development of more selective lethal agents.

The Bureau will not apply for registration of thallium for bird control until additional tests and evaluations are made.

The use of live traps presently appears to offer the greatest promise in controlling fruit damage in eastern Washington.

The selection of lethal materials and devices for bird control must be based on research studies. Although the Northwest studies have been underway since the fall of 1959, when considering the short seasonal period of starling concentrations involved, as yet comparatively little field testing of control methods has been devoted to this problem.

Coinciding with the development of the cooperative pilot-program in Oregon, the Bureau's small staff engaged in bird control was expanded at the Denver Wildlife Research Center, and one biologist, with headquarters at Davis, California was assigned to the Bureau's Pacific region. Subsequent increases in appropriations for bird control research have provided for the assignment of two research biologists to work as a team, with headquarters at Portland, and one biologist at Riverside, California. This expansion, supplemented by the efforts on the part of agriculturalists, and the state Departments of Agriculture, will aid a great deal in finding answers to the starling problems.

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