THE SCREW-WORM PROBLEM IN THE OCALA NATIONAL FOREST DEER HERD

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"Among all the insect pests that there on this earth, those that raise their maggots in the living flesh of animals are peculiarly loathsome. Screw-worms and blowflies have the doubtful honor of belonging to this group." (Cushing 1942).

Study of the screw-worm problem in the Ocala National Forest is one of the investigations undertaken by the State of Florida in Pittman-Robertson Project W-32-R. The objectives are to gain knowledge of the screw-worm's life history, its effect upon the deer herd, predisposing factors, survival rates, and to formulate management plans that would help control the screw-worm.

The Ocala National Forest is located in upper peninsular Florida, and lies within Marion, Lake, and Putnam Counties.

HISTORY

Screw-worms have a recorded history dating back to approximately 1842 in Texas. There is some evidence that native animals such as buffalo and coyotes were infested before the white man's time, but with the coming of the white man and his livestock, screw-worms became very common and the ranchers suffered from their ravages.

In 1933 the screw-worm became known in the Southeastern States. The first infestation was reported near Boston, Georgia, and from there it spread very rapidly through Georgia and Florida. The importation of infected livestock from the Southwest may have caused this initial infestation. By 1935 screw-worms were found in every county in Florida. Since 1935 severe outbreaks have been reported by all of the extreme Southeastern States, and most of the Southeastern States have suffered mild outbreaks.

Since 1935 the history of the screw-worm in the Ocala National Forest has followed a pattern similar to other infested areas. Following two or three mild winters a fairly severe outbreak of screw-worms would occur. Following a severe winter little activity could be noted. In other words, the past history of the screw-worm has been very erratic, but it is a continuing menace that errupts when conditions are favorable. A fairly severe outbreak of screw-worms occurred during 1954.

GENERAL INFORMATION CONCERNING THE SCREW-WORM FLY

The screw-worm fly *(Callitroga americana)* lays its eggs on a body wound of a warm-blooded animal. The screw-worm is usually unable to penetrate the unbroken skin of a healthy animal. The screw-worm, or larvae stage of the screw-worm fly, is a true parasite living on the tissues of these warm-blooded animals. Worms found in dead and decaying matter or coldblooded animals are from the common

blowflies and not the primary screw-worm fly. Man on occasions has become infested with screw-worms.

The screw-worm fly in size and coloration is very similar to some of the common blowflies. It is particularly hard to identify from one species of blowfly, and for many years these two species were considered as one, but it could not be understood why the worm was sometimes found on living tissues and sometimes on dead tissues. This led to studies that showed differences between the two species. The screw-worm fly, bluish green in color, has three dark stripes on its back. The eyes are reddish while below and between the eyes is a reddish or orange color.

The screw-worm is white in its early stage turning to a light brown or pinkish color upon maturity. The worm is approximately one-half inch long when mature. The head end is equipped with a claw-like appendage which is used to tear tissue, while the posterior end has a small opening through which it breathes. Screw-worms in a wound are almost always found grouped together in pockets with their heads and part of their body buried in the tissues while the posterior ends stick straight out. This gives them somewhat the appearance of a honeycomb. In some of the larger infestations the maggots or worms from blowflies can be found. These are found around the edges of the wound, feeding on dead material caused by the screw-worm activity. The blowfly worms are usually in a seething mass and can readily be distinguished from the screw-worm.

The type of wound caused from the activities of the screw-worm depends upon the species of animal infested and also the location of the infestation. In animals such as hogs and horses where the skin is stretched tight to the body, the screw-worms work straight into the flesh spreading out some as they go. In animals with loose skins they will spread out between the skin and flesh tissues as well as working straight into the flesh. In the case of a deer infested on the underside where the skin is fairly loose the screw-worms will spread under the skin and also into the flesh. If the same animal is infested on the back regions where the skin is fairly tight, they make a wound such as described for hogs and horses. One infestation on a deer's back measured ten inches in diameter. Screw-worms infesting a deer's ear will eat into the tissues between the two skin layers and then follow this tissue material up to the head. A very small hole can be present at the tip of the ear, which does not appear to be too serious, but in reality several hundred screw-worms may be nearing the head proper.

Most of the dead deer examined, that had infestations of screw-worms, were in at least fair physical condition. A few deer with bad infestations were in good physical condition. In almost every instance the deer's paunch contained a fair quantity of food. Deer apparently feed about the time the infestation causes death. In an area with a heavy population of screw-worms flies, such as is present in the Ocala National Forest at this time, reinfestation is common and a deer can be killed in a week's time. This may help to explain the fairly good condition of some of these animals.

It is sometimes quite difficult to notice a screw-worm infestation from field observations. This is especially true of infestations on the back or underside of the deer. A watery, bloody discharge can sometimes be seen running from an infestation, and a very bad odor is characteristic. The author has smelled these infestations on hunter killed deer before the wound was found. Careful examination of the deer's actions may indicate the presence of screw-worms. A deer with a bad

infestation on its head will almost invariably walk with its head considerably lower to the ground than normal. An infestation in the ear causes continuous shaking of the head and ears. A fawn that is by itself and tries to follow a person or acts lost or confused will usually have screw-worms in the navel. The author has evidence to suggest that the doe may abandon a screw-worm infested fawn, which may account for the fawn's peculiar behavior. A deer with an infestation will spend considerable time standing in water, neither feeding nor drinking.

LIFE CYCLE OF THE SCREW-WORM FLY

The female screw-worm fly lays her eggs on the edge of a wound of a warm-blooded animal. The number of eggs laid at a time may vary from 4 to 400. The female can lay up to 3,000 eggs which she usually deposits in masses of 200 to 400 eggs at four-day intervals. The eggs of the screw-worm fly differ from those of the blowflies in that they are deposited singly, then cemented into a shingle-like mass, while the common blowflies lay their eggs in any haphazard method and are not cemented together. Thus, the eggs of the screw-worm fly are readily identified from those of the blowflies.

The eggs hatch in 6 to 12 hours and the small worm immediately starts to feed upon the live tissues of the animal. Three to ten days later when the screw-worm has reached maturity, it will drop to the ground and burrow into the soil. Upon entering the soil the skin hardens and the worm enters the pupal stage of development. Usually 7 to 14 days later the fly will emerge from the soil. In cold weather the pupal stage may be extended to two months. If the fly has not emerged in two months the pupa will probably die.

Two to five days after the fly emerges from the soil it is sexually mature. The average life cycle is about 21 days although this time may be much longer under adverse conditions such as cold weather (Fig. 1).

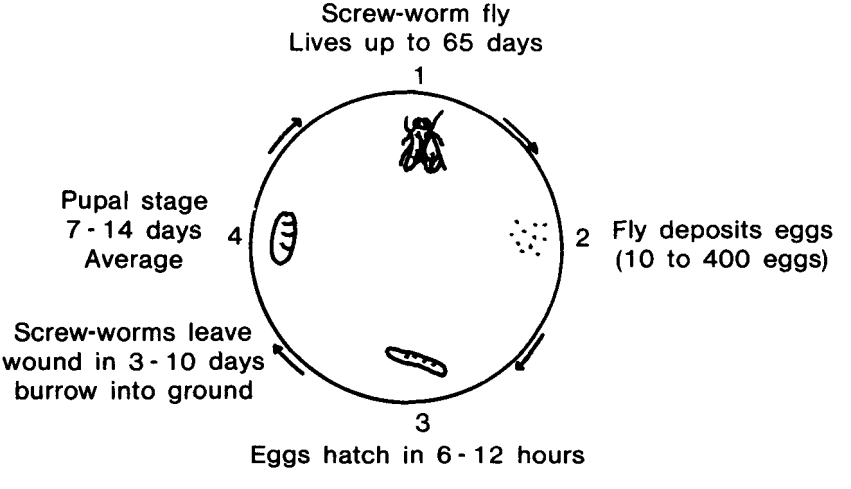

Fig. 1. Life cycle of screw-worm fly.

There are many predisposing causes for screw-worms in deer in the Ocala National Forest, and it is difficult to determine just which is the most serious. Ticks are probably the greatest offender. It was unfortunate for the Ocala Deer Herd in 1954 that both ticks and screw-worm flies were at high peaks of population. Many deer have been lost due to this deadly combination.

Ticks concentrate around the deer's ears and anus. Several hundred ticks have been removed from one ear of a deer. Close examination of a tick-infested ear will usually show several droplets of blood which is all that is needed to attract the screw-worm fly. An infestation on a deer's ear is serious since the worms can reach the head very quickly. Ticks that concentrate around the anus are not as serious as those around the ears, but they are the predisposing cause of many screw-worm infestations. Ticks undoubtedly are the predisposing factor in other locations besides the ears and anus but are not as serious elsewhere. Ticks do not concentrate as heavily on other areas the thick body hair gives some protection to minute wounds. On occasions heavy tick concentrations can be found on the head and upper neck regions.

Heavy concentrations of ticks are usually found on deer in poor condition, but during the past year the author has examined several deer in very good condition that have had concentrations of ticks, particularly on their ears. This is undoubtedly due to the very large tick population in the forest during 1954.

Gun-shot wounds are very important predisposing factors for screw-worm infestations. During the 1952 hunt ten deer and one bear were checked that had cases of screw-worms, while in 1953, 13 deer were checked with screw-worms. Almost all of these cases were caused from gunshot wounds. These few cases do not begin to account for the number of wounded deer that become infected with screw-worms and are never found. Between vultures and the warm humid climate a carcass lasts but a very few hours, making it difficult for the field man to determine the cause of death. Hunting is allowed in the forest during the months of November, December, and January and it is during this time that gunshot wounds become an important predisposing factor.

Another important predisposing factor is scratches and cuts received from snags, brush, fences, etc. Vegetation is dense in most of the Ocala National Forest and on occasions, especially when scared or startled, deer will scratch themselves going through the dense understory. There are a few barbed wire fences on the forest and they occasionally cause wounds on deer, but again this generally happens when the deer is startled or scared. Fawns and yearling deer are more likely than adult deer to get cut on a barbed wire fence. This predisposing factor is present the year round, but it is undoubtedly increased during the hunting season when deer are being chased by dogs.

During the fawning season the doe is susceptible to infestation in the vulva and the fawn in the navel. Although fawns are dropped the year round in the Ocala National Forest, the peak of fawning is reached in June and July. Unfortunately, it is at this same period that the screw-worm fly is also very active and many does and fawns are lost each year. The screw-worm fly was very active this last summer, 1954, and has taken a great number of this year's fawns and some does. It appears to the author that at this period the fawn is a little more susceptible to the screw-worm fly than the doe.

Three live fawns were picked up in the forest in the summer of 1954 with screw-worms in the navel. These fawns were treated and two of them lived while

the other died. All three had serious cases and would have died within a few days if left in the woods.

From the time the buck drops his antlers until new ones develop he is susceptible to injury to these antlers which in turn affords an opening for the screw-worm fly. The author recently saw a buck in velvet antlers with one antler almost completely eaten off. This is not an important predisposing cause, but the danger is there. Other predisposing factors such as biting flies, diseases of the skin, and injury by automobiles will occasionally cause infestation. The screw-worm fly is not particular about what causes the opening, but there must be a wound of some kind before it can reproduce its kind.

THE MOST COMMON LOCATIONS OF INFESTATIONS ON DEER

The location of a screw-worm infestation on a deer depends upon the predisposing cause. During the fawning season infestations are most common in the navel of fawns and the vulva of does. Ticks generally cause trouble on the ears and anus. Cuts and scratches generally occur along the back region, while gunshot wounds may be located on any portion of the body.

The majority of the cases observed in this forest are located on the head, back, and navel. A few cases have been noted on the sides, legs, and shoulders.

Table 1 does not include the 13 deer previously mentioned that were killed by hunters in 1953. This table includes only the months from March through August.

Table 1. 1954 screw-worm observations on Ocala deer herd.

Date	Sex	Age	Location of wound	Probable predisposing cause	Condition of animal
3-26	M	Adult	Back	Cut	Fair[a]
3-28	M	Adult	Back	Cut	Poor
4-30	F	Adult	Vulva	Fawning	Poor
5-8		Yearling	Shoulder	Cut	Fair
5-8		Adult	Shoulder	Cut	Fair
5-13	F	Adult	Hind leg	Cut	Fair
5-16	F	Fawn	Navel	Fawning	Fair[a]
6-5		Fawn	Navel and side	Fawning	Fair
6-5		Fawn	Navel	Fawning	Fair[a]
6-5		Adult	Ear	Ticks	Fair
6-28	M	Fawn	Navel	Fawning	Fair[a]
7-8	M	Yearling	Ear	Ticks	Fair[a]
7-8	M	Adult	Head	Ticks	Fair
7-13		Fawn	Navel	Fawning	Dead
7-14	F	Fawn	Navel	Fawning	Fair[a]
7-17	F	Adult	Ear and leg	Ticks and cut	Poor[a]
8-7	M	Adult	Head	Ticks	Fair
8-8	M	Adult	Head	Ticks	Dead

[a] These deer were all caught and examined closely.

EFFECT OF WEATHER UPON THE SCREW-WORM FLY

Weather is an important factor when considering the screw-worm problem since the screw-worm fly is unable to withstand cold. Freezing weather will kill the flies, and an average daily temperature of 54°F or less for a period of two months, will cause the pupa to die in the soil. This means the screw-worm usually survives the winter only in Florida, southern Texas, and Mexico.

In the Southeast the wintering area is usually limited to Florida, with the northern limit of survival about 50 miles south of the Georgia line. In extremely mild winters, which have occurred in the past, screw-worms survived in Georgia, Alabama, and South Carolina as well as Florida.

In the spring and summer months when the weather warms up the screw-worm fly starts migrating at a rate of 35 miles a week (Bruce 1952). Before the summer is over flies from Florida have migrated throughout Florida, the southern two-thirds of Georgia and the southeast corner of Alabama. The screw-worm flies from southern Texas also migrate during this same period. When winters are extremely mild and the screw-worm is not killed back to its usual limit, the following summer's migration may reach out much farther than described above.

Screw-worm outbreaks have been reported as far north as South Dakota not the result of natural migrations but due to the importation of infested stock or game. These importations usually cause an outbreak since the people are not equipped to combat the screw-worm and do not understand the problem. Any individual importing stock or a game commission importing game from an area infested with screw-worms should be very careful that none of the animals is infested.

The Ocala National Forest lies south of the winter survival line of the screw-worm so the screw-worm fly is present in the forest the year around. Weather still plays an important part in the screw-worm problem. On occasions a severe winter is experienced which cuts the problem to a minimum. Inversely, two milder than ordinary winters will build up the screw-worm problem to serious proportions. The past two or three winters have been relatively mild which has had much to do with the present outbreak.

Weather plays an important part in the life cycle of this fly. In warm weather a complete cycle may take place in 21 days or less while cold weather may delay this cycle for two months or more. Also the fly is much more active during warm weather than during cold weather. Livestock owners within the forest state that the screw-worm fly is most active during hot, rainy weather. The author has not been able to prove or disprove this theory.

SURVIVAL

Determining the survival of deer following an attack of screw-worms is very difficult. This problem is complicated since the ability to survive an attack depends upon the location of the infestation, the chances of reinfestation, age and condition of the animal, weather conditions and "perhaps others."

With the possible exception of an infestation in a fawn's navel, it requires repeated reinfestations to kill a deer. In other words, if only one fly lays its eggs on a body wound and the wound were never again reinfested there would be almost a 100 percent recovery. This happens occasionally in the forest especially

during the colder winter months. During the winter months, especially if they are fairly cold ones, probably the majority of deer will survive a screw-worm attack.

In the warm months during an outbreak of screw-worms such as was experienced in 1954, it is likely that the majority of infested deer will be killed. This is due to the heavy concentrations of screw-worm flies which continually reinfest the wound. The wound after the infestation starts is continually more attractive to the fly.

In order to understand how much damage a screw-worm attack can cause, it would be advisable to study its destructive powers. Two hundred screw-worms will destroy body tissues two inches in diameter and two inches in depth. When one considers that 2,000 to 3,000 screw-worms may feed upon one wound, we get a destruction of tissues six to seven inches in diameter and six to seven inches in depth. Few deer can withstand such injury and usually is killed before this stage is reached.

Even during the summer months, when deer are infested on their legs or lower parts of their body proper, they sometimes control these attacks by entering water holes and drowning the screw-worms. This leaves the wound open for reinfestation, but if the deer is lucky and the wound is not reinfested in a few days it will generally heal. Deer also lick the worms out of a wound but in so doing may get them in their gums and are then in a worse condition than before.

An infestation on the head or neck of a deer is extremely dangerous and few deer survive such an attack, especially if the flies are active and reinfestation is common. Infestations on the back, anus, vulva and navel are also extremely serious and the majority of animals so infested will die.

Cattlemen within the forest were contacted and asked how many of the calves got screw-worms in the navel. Their estimates ran from 50 to 75 percent during the warm summer months. They were also asked how many of these calves would die if left untreated. The estimates ran from 25 to 50 percent. The above figures do not old true for deer but they do show how serious the screw-worm problem is to new born animals. Fewer fawns than calves would be infested since the young fawn stays hidden and moves around very little the first few days. Although a small percentage may be infested, the author feels that almost all fawns with screw-worms in the navel will die.

The screw-worm fly carries the microorganism *(Streptococcus pyogens)* which is one of the causitive agents for the disease "Swollen Joints." The fly carries the microorganism to the navel of the fawn, and the screw-worm upon hatching carries it into the navel. It is then carried to one of the joints in the leg where it settles and causes a large swelling. Only one joint is usually infected but on occasions several may become infected. If death does not occur this leg usually becomes atrophied and useless. There is an adult doe in the forest in such a condition.

Three cases of "Swollen Joints Disease" have been observed in the last two years. Of these three cases, two were so infested with screw-worms. The screw-worm fly was probably the carrier in these instances.

The pre-hunting season census this past year showed approximately the same number of deer as the previous year. There should have been at least a 500-deer increase under ordinary conditions. Undoubtedly such things as highway accidents, disease, and illegal hunting took some of these animals, but the major factor in this loss was the screw-worm fly.

The survival of deer is dependent on temperature. During winter months, especially unusually cold ones, the majority of deer survive screw-worm attacks,

but during the warm summer months, if a heavy concentration of flies is present, the majority will die.

TREATMENT

The treatment of screw-worms is not difficult, but it is extremely difficult to catch an infested deer. The majority of deer treated have been fawns with infestations in the navel. One large buck was live trapped and treated for an infestation on his back, but this was an accidental trapping since the trap was set for a deer trapping project and not for that particular deer. One doe was captured by hand, but she died in about an hour. Any adult deer so badly infested that it can be run down is not going to live even with treatment.

There are several very good remedies available for the treatment of screw-worms, but probably the best one available today is "EQ 335 Screw-worm Remedy." The main ingredients are lindane (3 percent) and pine oil (35 percent). This remedy is used by the author on deer in the Ocala National Forest. Smears 62 and 82 have also given good results. EQ 335 has one great advantage that the old remedies did not have; that is, the ability not only to kill the screw-worms but to give protection to the wound for about seven days after treatment. "EQ 335 Screw-worm Remedy" comes in either liquid form or as a paste smear, the latter giving longer protection to the wound.

EQ 335 can best be applied to wound with a small brush. It should be worked well into the wound, paying particular attention to the deeper pockets. A coating should be applied completely around the wound and also on any exudate present. Wounds should be treated about every seven days, but a large wound should be treated twice the first week. In most instances one or two treatments will be sufficient.

In case of screw-worms in the mouth of the deer, do not use the above remedies, but instead remove the worms with forceps. Do not remove screw-worms from the navel of fawns, but treat and let the dead worms fall out.

It is advisable when trapping deer in a screw-worm area that all animals trapped should be examined closley for infestations and that all scratches or cuts be treated before the animal is released. A deer trapping project was conducted in the Ocala National Forest during the winter of 1953 - 54 and all of the bucks trapped had just lost their antlers. This left a very tender area that without exception had some blood on it caused from bumping into the sides of the trap. All of these bucks were treated before they were released.

SOME CONTROL STEPS TAKEN

Several steps have been taken in the Ocala National Forest to help relieve the screw-worm problem, but screw-worms will be present until the fly is eradicated. Screw-worms prefer thick brush country, which is common in the Ocala National Forest. The main hope of eradicating the fly lies in the work of the Agricultural Research Service. One control method being worked on is based upon the principle of radiation, and it promises to eradicate the fly.

Entomologists have perfected the technique of raising screw-worm flies by the thousands in the laboratory. They have found that X-rays sterilize the male during the sixth day in the pupal stage. A female upon mating with a sterile male will lay

eggs that are infertile. As the female mates only once her eggs will be infertile and no reproduction will follow. Field tests have shown that where there are five to ten times as many sterile males as normal males there will be very little reproduction. It is hoped that the mass release of these radiated males in Florida during a couple of winters and through the summers may eradicate the screw-worm fly from the Southeast.

Until this plan or some other plan is successful, the game manager should take steps to help alleviate the problem as much as possible. The first step taken in the Ocala National Forest was to control the wild hog population.

Until about 1952 wild hogs could be seen in droves up to 50. The heaviest fly concentrations are found around hogs. Their continual fighting, cutting and other activities make them ideal for screw-worm infestations. No effort was made to eliminate wild hogs, but their numbers have been reduced to the point where they do not constitute a serious screw-worm threat.

During the last few years a great increase in the use of the .30 calibre army carbine by hunters has been noted. The hunters continually complained of wounding deer which subsequently escaped. Examination showed this was due in part to the fulljacked steel bullets they were using. A regulation was then passed prohibiting the use of this type of ammunition in the forest. The purpose of this regulation was to cut down the loss of wounded deer and to help decrease screw-worm infestations.

The U. S. Forest Service has a multiple use program on the Ocala National Forest and one of these uses is cattle grazing. The cattle grazing on the area is of a scrub variety; blooded English stock cannot survive. These cattle serve as a constant host for the screw-worm fly. In the past the livestock owners have been negligent, or unable to take proper care of their stock. This left the cattle as a breeding ground for the screw-worm fly. A plan is being formulated by the U. S. Forest Service whereby the cattle owners will be required to take better care of their cattle. An animal the size of a bull can raise several thousand screw-worms before being killed. It is felt that closer supervision of livestock in the area will help cut down on the screw-fly population.

Screw-worms are destroyed in hunter checked deer and in carcasses found in the woods. Screw-worms will not stay in a wound very long after an animal is dead, although they did remain in a carcass about 12 hours in a recently checked deer. The destruction of the screw-worms in the few animals that can be collected before the worms drop out probably does little to help the overall problem.

Although dogs can be used legally to hunt deer during the hunting season, it is unlawlful to allow dogs to run at large in the forest during the rest of the year. Every effort has been made to stop this off-season chasing of deer by dogs, since chased deer are much more apt to scratch or cut themselves.

Five control steps have been discussed that are now being applied in the forest; others will be applied in the future as they are developepd. At best, these measures will only help control the screw-worm, but if the incidence of infestations can be cut by 25 percent the effort is worthwhile. The real solution to the screw-worm problem lies in the future, when and if the time comes that the screw-worm fly can be eradicated from the Southeastern States.

SUMMARY

The screw-worm fly established itself in Ocala National Forest between 1933 and 1935 and since that time has been a serious threat to the deer herd in that area. It lays its eggs in the wounds of warm-blooded animals. The eggs hatch into larvae, or screw-worms as they are more commonly called, in from 6 to 12 hours. The worm immediately starts feeding upon the tissues of the animal and through this feeding can destroy the animal. The screw-worms drop into the soil where they pupate and later emerge as screw-worm flies.

The most serious predisposing factors are ticks, gunshot wounds, scratches and cuts, and fawning. Of these ticks and fawning are the most serious. The majority of the infestations are located on the head, back and navel regions.

Weather is a very important factor in the screw-worm problem. Extreme cold will kill the flies, and if the temperature drops to 54°F or lower for a period of two months the pupa in the ground will be destroyed. An unusually cold winter in the Ocala National Forest reduces the screw-worm problem to a minimum.

During the colder winter months probably the majority of infested deer will recover, while during the warm months, especially if there is a fairly heavy concentration of screw-worm flies, the majority of the infested deer will probably die because of reinfestation. Screw-worms in the navels of fawns cause almost a 100 percent mortality. The screw-worm fly also carried the microorganism causing "Swollen Joints" to the navel of fawns.

Screw-worm infestations are easy to treat, but it is difficult to catch the deer. "EQ 335 Screw-worm Remedy" is the best remedy on the market today. This remedy not only kills the screw-worms but gives up to seven days' protection against reinfestation.

Controlling the wild hog population, outlawing the use of full-jacked bullets, more rigid controls on cattle, and efforts to control running of dogs during the summer are the measures established in the Ocala National Forest at present to try to reduce deer losses due to screw-worms.

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