

ARTICLES

THE PUBLIC'S VIEW OF MOSQUITO PROBLEMS IN AN ORGANIZED CONTROL DISTRICT¹KUN H. JOHN,² JOHN R. STOLL³ AND J. K. OLSON⁴

ABSTRACT. Mosquito control programs provide abatement services to residents of urban, suburban and rural areas. The differing perceptions of these programs by residents of the Jefferson County Mosquito Control District (Texas) are examined using a mail survey. Mosquito problems start occurring earlier in the year for urban residents. The average number of bites per hour per night was 11. Rural residents used more self-administered control methods and incurred greater expenditures for these efforts than other residents. A majority of respondents recognized the effectiveness of the mosquito control district's current abatement efforts, but 56% supported greater use of nonchemical control methods. The study methods are expected to be useful in other areas to address similar problems.

INTRODUCTION

Public opinion regarding mosquito problems and the need for controlling these insect pests in an organized mosquito control district is a very complex social issue to assess. This complexity results from the nature of the mosquito problems that exist in a given area and because each individual's attitude toward mosquitoes is different. Thus, what may be considered to be an important problem by some individuals may be considered less of a problem, or no problem at all, by others in the same district.

If it were possible to geographically classify or delineate control districts by the intensity of mosquito problems that individual residents perceived, then mosquito control program effectiveness could be enhanced. Therefore, the objectives of this paper were: to examine the geographical variation in perceived mosquito problems within one organized mosquito control district (i.e., Jefferson County Mosquito Control District in Texas); to examine the relationship between individual socioeconomic characteris-

tics and individual attitudes toward mosquitoes; and to assess resident opinions about the current control program and the quality of the outdoor environment with respect to mosquitoes.

METHODS

DESCRIPTION OF THE STUDY AREA. Jefferson County is an eastern coastal county in Texas with an area of 1,378 square miles. Over 200 square miles of the county consists of salt marshes that are sometimes flooded by wind-tides and heavy rains. In addition, approximately 150,000 acres of land are devoted to rice production in rotation with soybeans and pasturing of livestock. The county has an annual average rainfall of 53.1 inches and the relative humidity averages 62% at noon. The average daily temperature ranges from 68.5° to 78.3°F (ca. 20°-26°C), and the first killing frost occurs on or about December 7 and the last killing frost around February 24 of each year (Thompson 1970).

The southern portion of Jefferson County is primarily composed of tidal marshes and low lands. The land in neighboring Orange County across the Neches River, which runs through the eastern part of Jefferson County, is lower with more swamps. The marshes, lowlands and ricelands occurring in the county provide good mosquito breeding habitats. Port Arthur, a deep-sea port in the southern part of Jefferson County, also has a number of mosquito breeding sites because of the constant dredging that occurs along the intercoastal ship channel and the resulting disposal (mud) deposited in nearby marsh sites. Deep cracks form in the dredge disposal after it dries, which provide mosquito larvae with a shaded site that is well protected from both predators and mosquito control efforts. Cameron Parish, across Lake Sabine in

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the adjacent state of Louisiana, has over 1,000 square miles of salt marsh which is within easy mosquito flight range of Port Arthur. The southern half of this parish receives only limited mosquito control because it is primarily salt marsh and wildlife refuge.

The coastal marshlands of Jefferson County provide refuge for migratory waterfowl; and there are also over 5,000 beehives scattered throughout the county, with many of the hives located in aerial mosquito spray zones. Each beehive requires a 1,000 foot radius of untreated area to minimize the effect of chemical damage on the bees. Therefore, in an effort to reduce bee-kill, mosquito spray times are limited to a 2 hour period after sunrise and a 1 hour period before sunset. Other factors which limit spraying operations are temperatures below 70°F (21°C) and winds exceeding 10 mph.

The operations of the Jefferson County Mosquito Control District (JCMCD) are directed almost entirely towards the control of adult mosquitoes. These operations include both vector control and control of pestiferous mosquitoes. To a limited extent, the larval chemical spray control program is designed to eliminate mosquito breeding areas in populated urban locations. Until recently, about 85% of the JCMCD's efforts were concerned with the control of salt marsh and rice field mosquitoes. During the last few years, more emphasis has been placed on the control of urban-breeding mosquito populations in the county. The 3 major pest species of mosquitoes arising from the marshes and agricultural wetlands in the county are *Aedes sollicitans* (Walker), *Culex salinarius* Coquillett, and *Psorophora columbiae* (Dyar and Knab). The urban-breeding species receiving the most attention are *Aedes aegypti* (Linnaeus) and *Culex quinquefasciatus* Say. During the peak mosquito season, the JCMCD performs aerial spraying an average of 3 days/week and ground spraying 2 nights/week. No major source reduction programs are currently in force in the county; however, the JCMCD has begun to put more effort into treating storm sewers with insecticides during the past few years for larval and adult mosquitoes.

SURVEY APPROACH. The data used in this study were collected through a mail survey of randomly-selected property owners and renters in Jefferson County, Tx. The property owners are residents who provide financial support for the county mosquito control program through county property taxes. Renters do not contribute direct financial support for the program; but, they indirectly support the control program by paying rent to the tax-paying property owner. Names and addresses of property owners were taken from the tax roles provided by the Jefferson

County Tax Assessor's Office. In the case of renters, apartment numbers were randomly selected from lists of apartments provided by various apartment complexes located in the county. Current occupants of these apartments were sent questionnaires.

A pretest survey of 100 individuals was conducted during the summer of 1983. The actual survey was mailed in the fall of 1983. It consisted of 2,086 questionnaires sent to property owners and 1,300 questionnaires distributed to renters. A follow-up reminder letter was sent 1 week after the questionnaires were mailed to the property owners. Those subjects who still did not respond within an additional 2 weeks were mailed another questionnaire. No follow-up letters or additional questionnaires were distributed to the renters because of difficulties in distributing such mail consistently to this particular group of residents.

Of the 2,086 property owner questionnaires mailed, 129 (6.2%) were returned due to incorrect addresses. Of the remaining 1,957 property owners surveyed, 793 (40.5%) responded and 1,164 (59.5%) did not. Thirty of the answered questionnaires had invalid answers which left 763 usable responses or 39.0% of the total 1,957 property owner questionnaires mailed to correct address. From the renters, 204 usable responses (13.7% of the total questionnaires mailed to this group) were obtained.

Each questionnaire contained 26 questions and was 8 pages long. Most of the questions sought short answers or answers which were to be chosen from a prepared list. In most cases, respondents were given an option to specify some other alternative response if desired.

ANALYSIS AND PRESENTATION OF SURVEY DATA. There are a number of variables which might explain the county-wide distribution of mosquito problems perceived by the public in Jefferson County. The presentation in this paper uses basic statistical inference by comparing and/or contrasting the sample means and relative frequencies of the variables considered (Kmenta 1971).

RESULTS AND DISCUSSION

To condense the presentation, a selected subset of the 26 questions used in the survey are discussed here. Only the italicized questions are in the exact format use in the questionnaire sent to residents in Jefferson County.

SEVERITY OF THE MOSQUITO PROBLEM. *Geographical Distribution of the Mosquito Problem.* Almost half (49.3%) of the respondents indicated that they lived in urban areas, 39.7% were from suburban parts of town, and 11.0% considered their residence to be in a rural area. The

mean length of residence in Jefferson County for all respondents was 31.2 years (median 31.4 years), and the mean age of the respondents was 49.2 years (median 50 years).

Three-quarters (72.8%) of the respondents considered mosquitoes to be a problem around their homes during 1983. The remainder either indicated there was no mosquito problem (24.8%) or did not answer this particular question (2.4%). Of the respondents who reported a mosquito problem, 29.5% rated the problem as severe, 51.9% as moderate and 18.5% as mild. As shown in Table 1, 47% of rural residents regarded mosquito problems as severe, while 54% and 52% of suburban and urban residents, respectively, considered mosquitoes as a moderate problem.

Monthly Mosquito Activity by Location of Residence: In Fig. 1 the intensity of monthly mosquito activity is shown for each residential classification as perceived by survey respondents. Each point on the graph indicates the percentage of respondents who felt that mosquitoes were active during that particular month, e.g., 3% of the urban respondents indicated that mosquitoes were active in January and 3.2% in February. Mosquitoes were reported to be most active by respondents in all 3 residential locations during June, July and August. On average,

mosquitoes were reported as active 4.3 months out of the year and only reported as inactive throughout the entire year by 5.0%, 3.5% and 1.9% of urban, suburban and rural respondents, respectively.

Daily Occurrence of Mosquito Activity: The perceived time of mosquito activity around the home on a daily basis is also shown in Table 1. Respondents chose the category "night" most often, followed by "day and night".

Evaluation of the Quality of Environment: The following question was used to obtain the respondents' evaluation of the quality of the environment in Jefferson County with respect to mosquitoes.

QUESTION:

Which of the following best describes the year-round overall quality of the outdoor environment around your home with respect to mosquitoes? (Circle one number)

1. Zero bites during one hour at night
2. One to three bites during one hour at night
-
-
-
11. Twenty-eight to thirty bites during one hour at night
12. Thirty-one or more bites during one hour at night

Using the midpoint of these categories, the mean number of mosquito bites for the Jefferson County sample was estimated to be 11.0 bites/hr/night. The means computed for each residential location were 9.2, 12.1 and 14.9 bites/hr/night for urban, suburban and rural areas, respectively. Using a *t*-test, these variations in the mean number of mosquito bites reported by the respondents from each locational category were significantly different (0.01 level).

MOSQUITO CONTROL. Effectiveness of the Organized Mosquito Control Program: The economic and technical efficiency of current mosquito control activities conducted by the JCMCD were not examined in this study. However, the following direct inquiry question was asked to evaluate public opinion regarding the efficiency of the district's program.

QUESTION:

If the county government were to return the money it collects from your household for mosquito control, do you believe you could control mosquitoes around your home as well for the same amount of money? (For the non-taxpayers, a modified form of this question was used)

There was very little variation in answers to this question between respondents in the differ-

Table 1. Severity of mosquito problems and attitudes towards Jefferson Co. mosquito control district programs by residence area, 1983.

Question category	Urban (%)	Suburban (%)	Rural (%)
Respondent rating of mosquito problem:			
Severe	22.4	32.5	47.0
Moderate	52.1	54.1	43.4
Mild	25.5	13.4	9.6
Most active time of day for mosquitoes ¹ :			
Day	5.8	3.7	1.0
Night	63.7	62.9	53.5
Day and night	30.5	33.4	45.5
Respondent attitude toward JCMCD programs ² :			
Positive	45.5	31.3	42.1
Moderate	18.4	25.4	—
Negative	39.1	43.3	57.9
Respondent willing to support nonchemical methods:			
Yes	47.2	51.6	39.4
No	38.7	37.2	42.3
No answer	14.1	11.2	18.3

¹ As viewed by respondents in each locational category.

² Interpreted from respondent written comments in response to query in questionnaire.

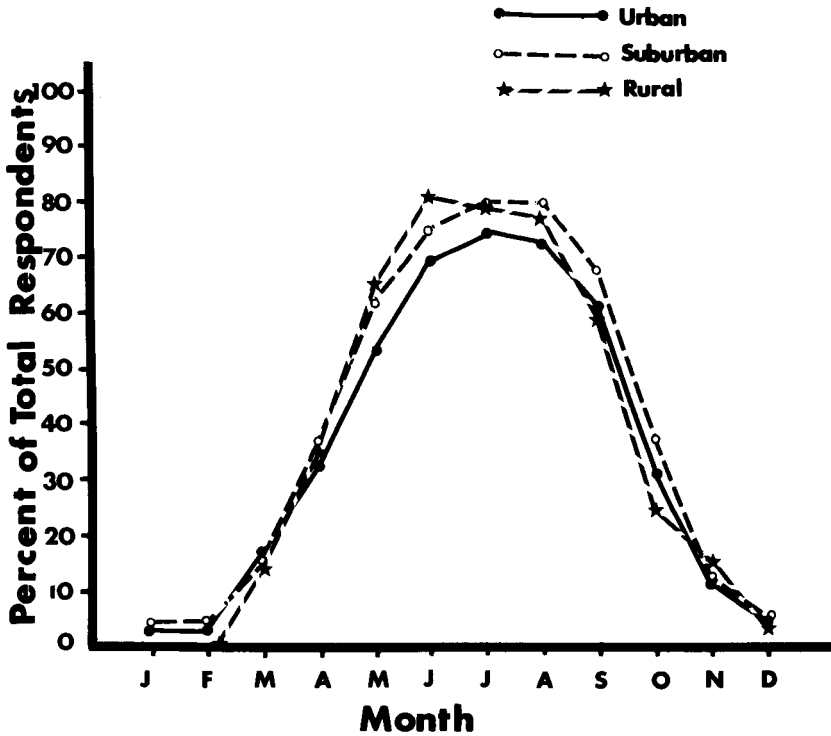


Fig. 1. Monthly mosquito activity as viewed by residents of Jefferson Co., TX, responding to a questionnaire in the Fall of 1983. The graph represents the percentage of total respondents in each locational category who considered mosquitoes to be active during a given month.

ent locational categories. The majority of respondents indicated that they could not control mosquitoes as well as the JCMCD (88.4%, 88.4% and 84.4% for urban, suburban and rural respondents, respectively). A small proportion of respondents felt they could control mosquitoes as well as the JCMCD (9.4%, 8.3% and 11.5%, respectively) and an even smaller proportion felt they could provide mosquito control better than JCMCD (2.2%, 5.4% and 4.2%, respectively). Those who indicated they could control mosquitoes better than the JCMCD usually responded with conditional answers (e.g., "if the neighbor sprayed at the same time ...") or indicated reliance on inadequate control measures (e.g., electronic insect-killing devices).

Respondents were also given an opportunity to write any comments or suggestions they might have regarding operation of the JCMCD and 173 responded. These comments were categorized with regard to respondent attitude toward the JCMCD and the quality of services it provides (Table 1). Respondents from the urban and suburban areas of Jefferson County tended to have a positive or moderate attitude toward the JCMCD's current program. Rural respondents had bipolar opinions with more negative

than positive responses about the current mosquito control program and none indicating a moderate attitude.

Most of the negative responses were related to the environment around a water canal which runs through the populated areas of Jefferson County. Respondents believed the canal to be a major source of immediate mosquito problems around their homes. It is doubtful, however, that the canal itself is in fact a "source" of mosquitoes due to a high level of natural predation in this area. Another explanation needing consideration is that the canal serves as a flyway or a source of resting sites for adult mosquitoes migrating in from other areas.

Incidence of Personal Protection Against Mosquitoes: Additional mosquito control methods used by residents of Jefferson County are indicated in Fig. 2. Each bar shows the proportion of respondents in each residential category who use a particular method of control.

Results indicate that rural residents in the county use more individually-purchased chemicals and control devices (excluding repellants and screens) than do suburban and urban residents. This difference is also indicated in the amount of money spent on these control meth-

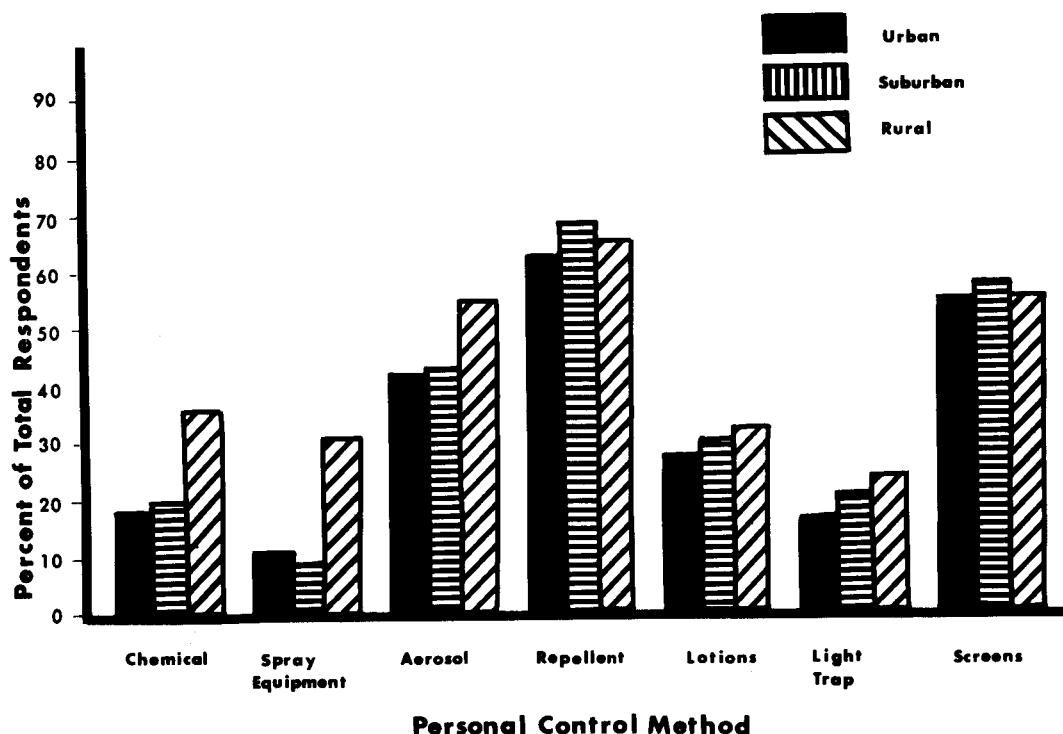


Fig. 2. Personal mosquito control methods used by respondents to a questionnaire sent to residents of Jefferson Co., TX, during the Fall of 1983.

ods (\$20.05, \$24.74 and \$74.60 for urban, suburban and rural residents, respectively).

Opinions about Nonchemical Control: Respondents were asked about their willingness to support the use of nonchemical control methods, after they were informed of some of the potential environmental damages caused by chemical use (e.g., destruction of bees and other small insects, destruction of shrimp and vegetation in treated ditches, and damage to paint finish). The respondents were also told that these nonchemical methods required more money than chemical-dependent methods to maintain the same degree of mosquito control. The suggested nonchemical methods included mosquito-eating fish, bacteria and fungi. The following question was then posed:

QUESTION:

Would you be willing to contribute more money to support the use of nonchemical methods by the Jefferson County Mosquito Control District?

More respondents were willing to support (i.e., pay for) than not support the additional costs of these methods (Table 1). This willingness to pay, however, seemed to be centered more in urban and suburban areas of Jefferson County than in the rural areas. Of the rural respondents

unwilling to support the suggested nonchemical methods, 43.2% felt that, while environmental damage (associated with insecticides) is a "significant problem", they should not have to pay the additional costs associated with the nonchemical alternatives. Most of the respondents choosing this reason for nonsupport felt that the federal government should pay at least a part of the costs associated with these methods.

Another 35.1% of the rural respondents unwilling to pay for nonchemical control alternatives indicated that they believed environmental damage (associated with insecticides) was "not significant". The majority of the urban (58.0%) and suburban (49.6%) respondents unwilling to support nonchemical methods also chose this particular reason.

ATTITUDES, MOSQUITO BITES AND SOCIOECONOMIC CHARACTERISTICS. Individual reactions and attitudes toward mosquitoes were found to vary not only on the basis of respondent residence location in Jefferson County (i.e., urban, suburban or rural), but also among people living in the same locational area. This may be attributable to differing respondent socioeconomic characteristics, e.g., age, sex, family composition, family size and knowledge about mosquitoes.

Examination of the influence of socioeco-

conomic characteristics on respondent attitudes toward mosquitoes in Jefferson County used number of mosquito bites/hr/night reported by each respondent as a comparative base of information. The number of mosquito bites that respondents received each night was felt to influence their view of environmental quality with respect to mosquitoes. Persons living in the same locational area should, in general, have the same level of mosquito bites/hr/night. Differences in the reported number of mosquito bites received/hr/night by such individuals reflects, to some degree, variations in socioeconomic characteristics which influence attitudes toward and perceptions of mosquitoes.

Age and Mosquito Bites: The mean number of mosquito bites reported by Jefferson County respondents is reported in Table 2 by age bracket. The number of reported mosquito bites/hr/night decreased for the oldest age category.

Sex and Mosquito Bites: Female respondents reported fewer mosquito bites (mean: 10.5 bites/hr/night) than did the male respondents (mean: 11.2 bites/hr/night). This was also true when respondents were disaggregated by residence location. Females reported 8.9, 11.6 and 12.2 mean bites/hr/night for urban, suburban and rural areas, respectively, while males reported 9.4, 12.3 and 16.1, respectively. One explanation may be that females spend less time outdoors on a daily basis in comparison to their male counterparts. However, this was not specifically examined.

Children and Mosquito Bites: Families with

children reported slightly more mosquito bites than families without children (Table 2). This was consistent with expenditures for mosquito control. Families with children spent more money to control mosquitoes than did families without children (Table 2).

Rating of Mosquito Problems: Three-quarters (76.8%) of the respondents considered mosquitoes to be both a nuisance and a public health threat. Another 19.2% reported mosquitoes as a nuisance only and 3.2% reported them only as a public health threat. Respondents who reported 5.7 (median 2.0) mosquito bites/hr/night felt there was no mosquito problem around their home. Those who said they received 7.7 (median 5.0) bites/hr/night responded that the mosquito problem was mild; those who reported 11.5 (median 11.0) bites/hr/night described a severe mosquito problem.

SUMMARY AND CONCLUSIONS

Results of this study indicate the level of mosquito problems, as viewed by the public, can be different between residence types. Mosquito problems tended to be rated as severe more often by respondents in rural areas than in either the suburban or urban areas (Table 1). Also, the number of bites/hr/night are perceived as higher in rural areas than in either suburban or urban areas. It, therefore, would be expected that people living in rural areas might have reason to view the current mosquito control program more negatively (as found here) than those living in other areas of the county.

Families with children were more likely to consider mosquitoes a serious problem than families without children. Families with children also used more of their own control methods. Age did not display a consistent relationship with the number of reported mosquito bites, although the oldest age group (over 60) tended to experience fewer bites. Also, males reported a higher number of mosquito bites than females.

This study did not attempt to measure resident tolerance to mosquito bites. However, a study performed in New Jersey by Headlee (1932) estimated that 4 mosquito bites/night was the human tolerance level. Robinson and Atkins (1983) stated that "there was not a distinct difference in the mean number of bites/night tolerated by the Lake Shores (Virginia) residents and the number of bites/night that were considered indicative of a mosquito problem in the area." The mean number of bites reported in the present study gives an indication as to the quality of the outdoor environment in Jefferson County, but, may or may not indicate a tolerable or intolerable level of mosquitoes. The question, as presented in the questionnaire,

Table 2. Mean number of mosquito bites per hour per night and money spent annually for mosquito control, 1983.

Question category	Urban	Sub-urban	Rural	Total
Reported mosquito bites/hr. by respondent age group:				
30 yrs. or fewer	9.7	12.1	14.4	11.4
31-40 yrs.	10.9	12.0	17.1	11.9
41-50 yrs.	9.5	11.3	19.8	11.7
51-60 yrs.	9.3	13.9	9.2	10.9
61 yrs. or more	8.1	10.1	14.2	9.3
Reported mosquito bites/hr. by family type:				
Without children	9.2	11.3	14.6	10.5
With children	9.4	13.6	15.4	11.9
Dollars spent annually for mosquito control by family type:				
Without children	19.0	21.7	22.3	20.7
With children	29.2	28.0	54.5	31.4

does imply, however, that the greater the mean number of bites, the worse the overall quality of the outdoor environment around the home of the respondent.

The majority of Jefferson County residents sampled viewed the current JCMCD mosquito control program as effective. In general, residents of Jefferson County appeared to be sensitive to the impact of insecticides on the environment. Also, they were supportive of implementing alternative nonchemical mosquito control measures, even if it would mean additional costs to individual households. This was particularly true in the urban and suburban areas of the county (Table 1). Even in rural areas, respondents generally viewed chemicals to be harmful to the environment; and if alternative ways (aside from raising county taxes) to pay for the additional costs of using nonchemical mosquito control tactics could be found, they, too, would possibly be more supportive of the use of these alternative control methods. However, a more detailed comparison of additional costs associated with these methods and the magnitude of the financial support available for mosquito control would be necessary to determine their economic feasibility.

While some of the specific information discussed in this paper is likely to pertain only to Jefferson County, TX, the general trends may be applicable to public attitudes about mosquitoes and their control in other counties or mosquito control districts. The *mail survey* method employed in this study *was useful* in obtaining the kind of information needed to accomplish the objectives of the study. Although the response rate was not high, it is comparable to many other random population mail survey

studies. The questionnaire that was used proved itself valuable not only in gaining direct information regarding the public's attitudes toward mosquitoes and their control, but it also provided a mechanism whereby other inferences could be made indirectly, e.g., the relationship between the number of mosquito bites and residents view of mosquito problems as a nuisance or public health threat.

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