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A Survey on Egg Parasitism and Overwintered Adult Population of Sunn Pest [(*Eurygaster* spp.) (Hemiptera: Scutelleridae)] in Usak Province, Türkiye

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ABSTRACT

Sunn Pest, *Eurygaster* spp. (Hemiptera: Scutelleridae), is the most important pest being able to cause significant losses on wheat yield and quality in Türkiye. To monitor the overwintered adult population, this study was carried out in 41 sites in 19 locations during two consecutive years. The samplings were performed in April and May in both years. During the study, the economic threshold, which is 0.8 overwintered adults per square meter, was obtained only in Yesildere location, and the number of adults in other locations remained quite low. Moreover, it was determined that the parasitization rates varied between 48.2% and 70.1% in the locations where egg masses were collected. As a result of this study, it was found that the number of adults was higher in locations with high altitudes and close to overwintering areas. Therefore, more attention should be paid to survey studies in similar locations.

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Uşak İlinde Kışlamış Süne [(*Eurygaster* spp.) (Hemiptera: Scutelleridae)] Ergin Populasyonu ve Yumurta Parazitlenmesi Üzerine Sürvey

ÖZET

Türkiye'de buğdayın verim ve kalitesi üzerine önemli kayıplara neden olan en önemli zararlı Süne, *Eurygaster* spp. (Hemiptera: Scutelleridae) dir. Bu çalışma kışlamış ergin popülasyonunun takibi amacıyla, iki yıl süresince 19 lokasyona ait 41 ünitede gerçekleştirilmiştir. Örneklemeler her iki yılda da nisan ve mayıs aylarında yapılmıştır. Çalışma boyunca ekonomik zarar eşiği olan 0.8 kışlamış ergin/m^2 sadece Yeşildere bölgesinde tespit edilmiş diğer alanlardaki ergin sayıları oldukça düşük olmuştur. Parazitlenme oranının tespiti için yumurta paketi toplanan lokasyonlardaki parazitlenme oranları %48.2 - %70.1 arasında değiştiği tespit edilmiştir. Ayıca bu çalışma sonucunda ergin sayılarının rakımı yüksek ve kışlaklara yakın olan alanlarda daha yüksek olduğu belirlenmiştir. Dolayısıyla bu ve buna benzer bölgelerdeki sürvey çalışmalarına özen gösterilmelidir.

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INTRODUCTION

Cereals, which include products such as barley, wheat, corn and rice, are a rich source of carbohydrates and play an important role in dietary habits all over the world. Grain is produced in 50.6% (724.2 million hectares) of the world's agricultural land (1.43 billion hectares). This rate was 59.1% (10.7 million ha) in Türkiye, which has 18.1 million hectares of agricultural land (Faostat, 2021). Among the cereals, the most grown crop has been wheat due to its high adaptability both in the world and in Türkiye. Besides utilizing in human nutritional flour, bulgur (cracking and precooking of wheat grains), pasta and starch obtained from wheat, its stem is used in the paper-cardboard industry and animal nutrition (Kan, 2000; Flowers, 2012).

Sunn pest (*Eurygaster* spp.) (Hemiptera:Scutelleridae) is one of the most

important pests affecting the yield and quality of wheat, which is an indispensable resource in our daily diet and also has a strategic position economically. While there are 15 species of *Eurygaster* genus in the world, only seven species of them have been identified in Türkiye. Among them, *E. integriceps* (Put.), *E. maura* (L.) and *E. austriaca* (Schr.) have been economically damaging and are the most common species (Simsek et al., 1996). It feeds on wheat, barley, rye and oats belonging to the Poaceae family and their wild forms. Commercially, the most important damage is found on the wheat plant, which it prefers more than other grain types. Although Sunn pest is univoltine and active for only 3 months a year, it is a pest that can cause up to 100% product loss if control measures are not taken (Davari and Parker, 2018).

For the management of this pest, the use of synthetic insecticides is very common owing to their short-term effect and easy application. In Türkiye, the pest management method, which started with physical control in 1928, has turned into chemical control as of 1955. The chemical application, which was made with aircraft and ground tools until 2005, was carried out only with ground tools in the following years (Kocak, 2007). The negative effects of these chemicals on the environment, natural enemies and human health have been increasing as a result of unconscious and unnecessary use. Hence determining the population density of the pest plays a key role in deciding on the use of chemicals against pests.

Egg parasitoids are one of the most important actors suppressing population growth of Sunn Pest (Kivan, 1998). As such, *Trissolcus* spp. belonging to Scelionidae (Hymenoptera) family have come into prominence. In some locations of Türkiye, due to the effectiveness of Sunn Pest egg parasitoids, either no insecticide is applied or partially done (Cetin et al., 2012).

In this study, which was conducted in 2020 and 2021, the overwintered adult population and egg parasitism of Sunn pests was observed and their density were compared to the studied locations.

MATERIAL and METHODS

Survey area and Sampling method

The studies were carried out in 19 locations of Usak province, where barley and wheat are cultivated intensively, with altitudes varying between 851-1043 m. Each location was divided into sites ranging in size from 100 to 500 ha, and overwintered adults (OA) were sampled in 41 sites (7000 ha) in total. Controls were made in the wheat and barley fields from the beginning of April, when the daily temperatures reached 15°C in both years, and the counting of the overwintered adults was started 10-15 days after the first adults were detected. The samplings were carried out between 10-26 April in 2020, while in 2021 it was launched on 20 April due to rainy weather and were completed on 7 May (Table 1). OA were counted with the help of 0.25 square meter frames.

Table 1. The areas and dates on which the overwintered adult were counted in 2020-2021
Çizelge 1. 2020-2021 yıllarında kışlamış ergin sayımı yapılan bölge ve tarihler

Location	Sampling date		Altitude (m)	No.of thrown frame
	2020	2021		
Bozkus	10-13 Apr	21 Apr	881	240
Bolme	24 Apr	27 Apr	884	160
Carıkkoy	13 Apr	03 May	953	160
Gucer	10 Apr	20 Apr	911	160
Demiroren	22 Apr	26 Apr	951	160
Elmacik	22 Apr	28 Apr	878	160
Hocalar	17 Apr	29 Apr	863	160
Ikisaray	14 Apr	21 Apr	869	160
Kalfa	15 Apr	22 Apr	868	160
Karahasan	22 Apr	28 Apr	853	160
Karlik	14 Apr	04 May	1043	240
Kayagil	24 Apr	27 Apr	914	80
Muharremsah	15 Apr	22 Apr	879	240
Ovademirler	20 Apr	29 Apr	884	160
Ortakoy	13-14 Apr	07 May	991	240
Selikler	20 Apr	30 Apr	861	160
Susuzoren	17 Apr	06 May	913	240
Yavi	26 Apr	05 May	851	160
Yesildere	25 Apr	26 Apr	968	80

Forty frames were randomly tossed to each site and the number of adults found within the frame was recorded. Also, parasitization rates in egg masses of the pest were determined in the locations where the mean number of OA per square meter was above economic threshold (0.8 OA/m²), and in four locations close to overwintering areas (Carikkoy, Gucer, Karlik and Kayagil) (Adiguzel, 1981). For this purpose, at least 20 egg masses were collected from each location, when 20-30% of the eggs were in the anchor-sign stage. The collected egg masses were placed in glass tubes and kept at room temperature for 5 days. The eggs that turned black in color were considered as parasitized and the parasitization rates of the locations were determined (Simsek et al., 1985).

Data analaysis

The number of OA collected from the sites belonging to the locations was divided by the number of frame thrown, and the mean number of OA of that location was calculated. As the values of each location based on the years were not normally distributed, Mann–Whitney test was performed to evaluate whether the difference between the mean number of OA obtained from each location in the two survey years was significant. In addition, one-way analysis of variance was applied to the mean numbers of OA of the studied locations, which providing homogeneity of variance and normality, and the different groups were detected by the Tukey multiple comparison test. All statistical analyzes were performed in SPSS 24.0 software package.

The number of adult Sunn pest collected from the locations based on their altitude were mapped using the Surfer 22.2 software program. On the wireframe map, the z value represented the altitude of the locations, while the z value on the Contour map expressed the number of OA. Also the inverse distance method was used for interpolation in contour map.

RESULTS and DISCUSSION

Throughout the study, OA were counted in a total of 3280 frames and 223 adult insects were obtained. Except for Yesildere, no significant difference was found between the number of OA of the locations in 2020 and 2021 (Fig.1).

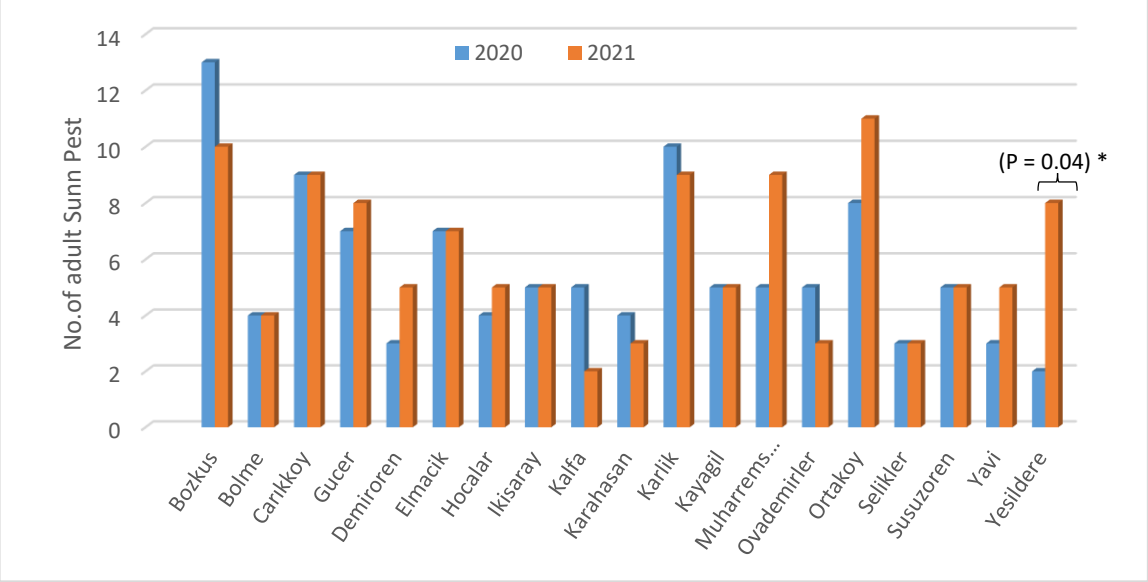

Figure 1. Number of adult Sunn Pest collected from studied locations in 2020 and 2021. The bars labeled with an asterisk (*) means that the data between the two survey years differ at the signifcance level of 0.05.

Şekil 1. 2020 ve 2021 yıllarında toplanan ergin süne sayıları. Yıldız ile işaretlenmiş çubuklar iki sürvey yılı arasında 0.05 önem seviyesinde farklılık olduğunu göstermektedir.

In 2020, mean number of adult sunn pests per frame were the lowest in Demiroren, Muharremsah, Selikler, Susuzoren and Yavi (0.04±0.02), while it was the highest in Kayagil with a mean of 0.13±0.05 ($F_{18, 1621} = 75.85$; $P < 0.001$). As for 2021, the locations with the lowest and highest means were Kalfa (0.03±0.02) and Yesildere (0.2±0.07), respectively ($F_{18, 1621} = 210.35$; $P < 0.001$) (Fig. 2). Additionally, it was determined that the difference between the mean number of OA in 2020 (0.065±0.01) and 2021 (0.07±0.01) was not statistically significant ($P = 0.57$). In 2020, the mean number of OA per square meter (four frames) obtained from the locations did not exceed 0.8. In 2021, it was determined a mean of 0.8 (0.2 per frame) in only Yesildere, while the means in other locations were low.

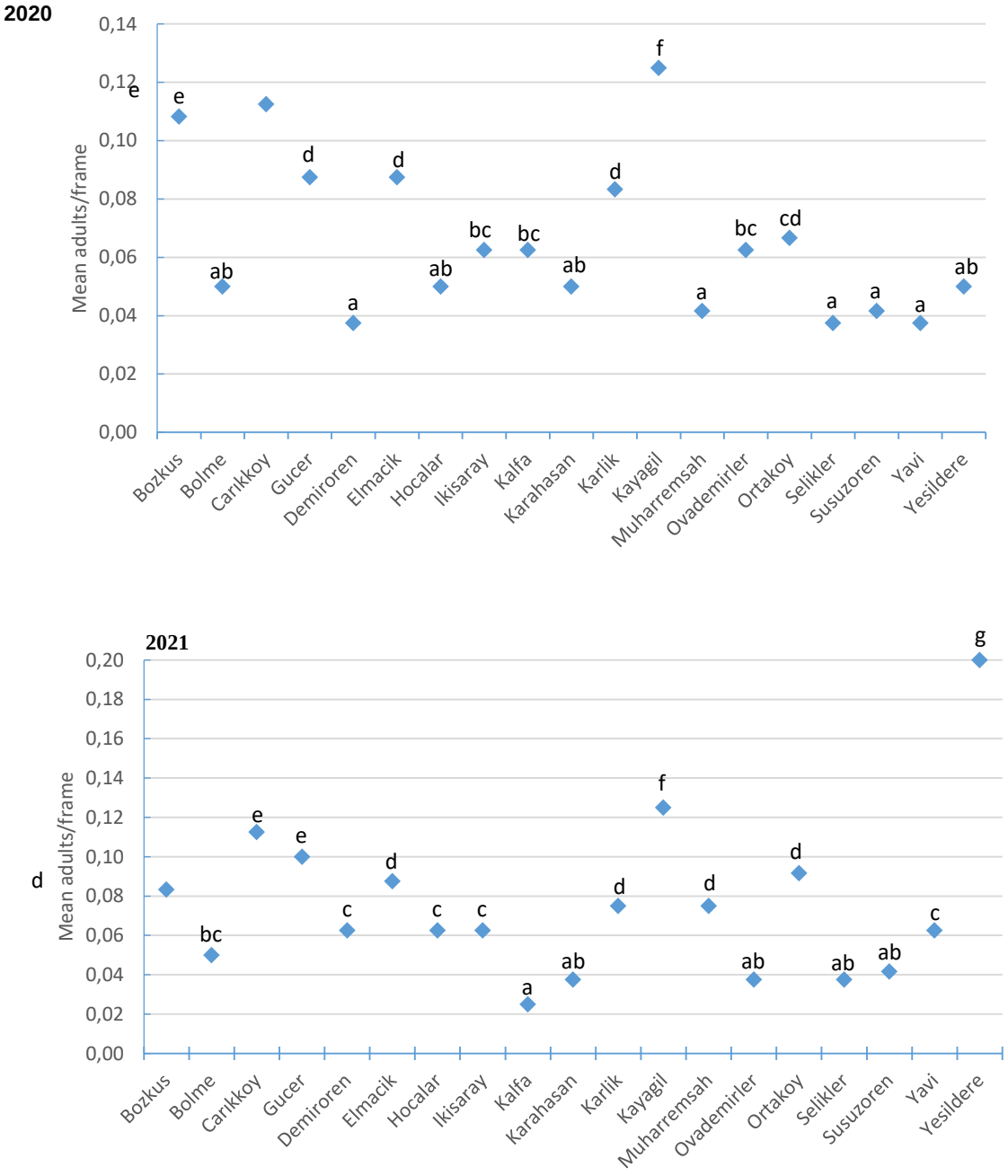

Figure 2. Mean numbers of adult sunn pest per frame during the survey. The difference between the averages with the same latter is not statistically significant (Tukey $p \geq 0.05$)

Şekil 2. Sürvey boyunca her çerçevedeki ergin süne ortalaması. Aynı harf ile gösterilen ortalamalar arasındaki fark istatiksel olarak önemli değildir (Tukey $p \geq 0.05$)

In May, 33 egg masses containing a total of 462 eggs were collected from the location in question. While 224 of these eggs were found to be parasitized, no parasitization was observed in 238 of them. The parasitization rate of the location was calculated as 48.5%, and since this rate was over 40%, spraying was not recommended (Kutuk et al., 2009). Furthermore, parasitization rates in Carikkoy (21 egg masses), Gucer (29 egg masses), Karlik (21 egg masses) and Kayagil (27 egg masses), where egg masses were collected, were 55%, 56.1%, 70.1% and 48.2% respectively. As the number of overwintered adults per square meter in the locations, where the egg masses were collected, increased, the parasitization rate decreased. However this rate was not below 48%. Therefore, while the efficiency of egg parasitoids is sufficient in this study, the parasitization rates should be meticulously controlled

in cases where the number of overwintered adults per square meter is one or more. The number of OA per square meter determined in studies conducted in different locations of Türkiye and in other countries was higher than that of the present study (Simsek et al., 1985; Popov et al., 2003; Canhilal et al., 2005; Kutuk et al., 2009; Salis et al., 2013; Kapustkinaa and Khilevskiy, 2019). Despite the presence of suitable overwintering areas for Sunn pests and not applying insecticide in the studied areas, the low number of overwintered adults found shows the effectiveness of natural enemies. Especially the egg parasitoid *Trissolcus* spp. (Hymenoptera: Scelionidae) is one of the most important species among these natural enemies. So far, 17 *Trissolcus* species have been identified as egg parasitoid of Sunn pest in Türkiye (Kocak, 2007) whereas 3 of them were reported in the studied locations dominanted by *T.semistriatus* Nees (Kocak and Kilincer, 2001). *E. integriceps*, which is one of the two common species in Türkiye, was the dominant species in southeastern Anatolia and Thrace, while *E. maura* was the main species in Central and Western Anatolia (Kocak and Babaroglu, 2005; Koçak et al., 2014). Therefore, *T. semistriatus*, which mostly preferred eggs of *E. maura*, was more efficient in the study area (Brown, 1962a). It was reported that this parasitoid species spends two to three generations on the eggs of the Sunn pest during their oviposition period, while it prefers the eggs of other scutellerid and pentatomid species for the remaining six generations (Kivan, 1998; Kocak, 2007; Kodan and Gurkan, 2016). In the survey areas, uncultivated areas in the field boundaries, alfalfa and vetch fields as well as orchards have created natural habitats and shelters for alternative species that host *Trissolcus* species. As such, Zatyamina et al. (1976) and Zomorrodi (1979) found that *Trissolcus* species moved on to sunflower, corn and paddy fields following grain harvest. Moreover, Oak, juniper, almond and pear trees, which are abundant in the location, provide a suitable environment for overwintering of these parasitoids thanks to their thick bark, as well as being an important food source with the nectar they produce. Similarly, Gozuacik (2011) pointed out that alternative host eggs for *Trissolcus* spp. appeared for 6 months from April to September in areas with natural woodland and annual plants. In addition, Simsek and Ozer (2001) ascertained that parasitization rates were higher in fields near such areas.

It was reported that *E. integriceps* was dominant species in the Southeastern part of Türkiye and some areas of Thrace location, where the Sunn pest population density was above the economic threshold with lower parasitization (Koçak et al., 2014). Therefore, population density of *T.vassilievi* Mayr, which mostly prefers *E.inetgriceps* eggs in such locations, should be increased (Kocak and Kilincer, 2001; Iranipour et al., 2010). In addition, monoculture and scarce woodland in these locations are issues that need to be corrected in terms of the continuity of the parasitoid population.

The number of OA was lower Bolme, Demiroren, Hocalar, Karahasan, Seliks, Susuzoren and Yavi, where are farther from the overwintering areas when compared to Karlik, Carikkoy, Kayagil and Ortakoy locations, where are closer to the overwintering areas and with higher altitudes. In this context, Karimzadeh et al. (2011) emphasized that the migration of Sunn pest from overwintering areas to fields was not randomly occurred while wind direction and speed had a significant effect on migration behavior, thus the edge effect was an important parameter in the distribution of the pest.

It was found that there was a moderate, positive, linear relationship between the number of OA obtained from the locations and the location altitudes ($R = 0.52$; $P < 0.05$). The number of OA was higher in the locations with high altitudes (Fig.3). It was reported that in locations where do not have high summer temperatures like survey locations, some groups of Sunn pest do not migrate to higher altitude from overwintering areas and spend their aestivation and overwintering periods under suitable vegetation at the edge of the harvested fields (Brown, 1962b; Parker, 2011). It has been considered that this situation is one of the reasons for the correlation between altitude and the number of OA.

CONCLUSION

Sunn pest populations remained below the economic threshold in the studied years in Usak province of Türkiye. It has been concluded that if woodland and green belts present in the survey areas and providing shelter for parasitoids are preserved, there will be no need for chemical control against Sunn pest in the following years. Moreover, in terms of follow up of the sunn pest population, surveys should be continued primarily starting from locations with high OA populations in this study. The observations should be made for the E. integriceps species, which is not found in the study area and is a problem for other locations, and if detected, its density and parasitization rates should be examined. The essential points such as host selection of parasitoids and host susceptibility should be well evaluated, and wrong practices should not be made in the study area where the natural enemy-host balance has been established.

Author's Contributions

The contribution of the authors is equal.

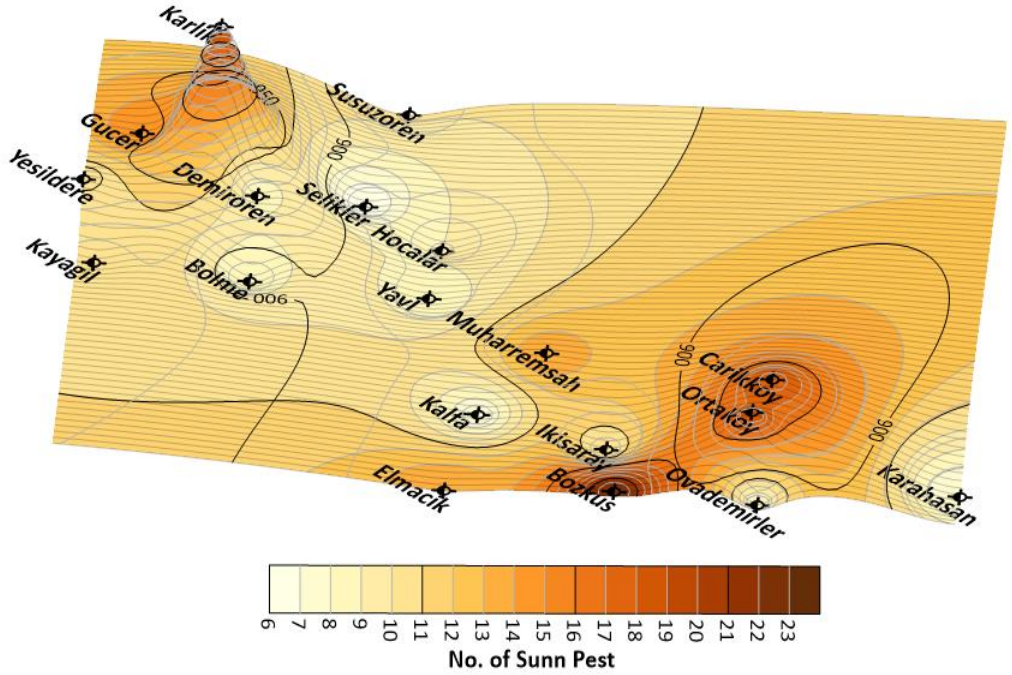

Figure 3. 3D-wireframe plots of the location elevation and Contour map of number of adult Sunn Pest obtained during the study.

Şekil 3. Çalışma süresince elde edilen ergin süne sayılarına ait kontur harita ve bölge yükseltilerinin 3D tasarımı

Statement of Conflict of Interest

Authors have declared no conflict of interest.

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