

## **Modified Petraborg index applied to the sampling of male crickets by aural detection**

Authors: Cano-Santana, Zenón, Romero-Mata, Ariana, and Pérez-Escobedo, H. Marcela

Source: Journal of Orthoptera Research, 17(1) : 111-112

Published By: Orthopterists' Society

URL: [https://doi.org/10.1665/1082-6467\(2008\)17\[111:MPIATT\]2.0.CO;2](https://doi.org/10.1665/1082-6467(2008)17[111:MPIATT]2.0.CO;2)

---

BioOne Complete ([complete.BioOne.org](https://complete.BioOne.org)) is a full-text database of 200 subscribed and open-access titles in the biological, ecological, and environmental sciences published by nonprofit societies, associations, museums, institutions, and presses.

Your use of this PDF, the BioOne Complete website, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at [www.bioone.org/terms-of-use](https://www.bioone.org/terms-of-use).

Usage of BioOne Complete content is strictly limited to personal, educational, and non - commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

---

BioOne sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

# Modified Petraborg index applied to the sampling of male crickets by aural detection

Accepted July 10, 2008

ZENÓN CANO-SANTANA, ARIANA ROMERO-MATA AND H. MARCELA PÉREZ-ESCOBEDO

Departamento de Ecología y Recursos Naturales, Facultad de Ciencias, Universidad Nacional Autónoma de México. Ciudad Universitaria. 04510 México, D. F. MEXICO. Email: zcs@fciencias.unam.mx, arianromat@yahoo.com.mx, salamandram@hotmail.com

## Abstract

A modified Petraborg index is proposed to correct an underestimation error in the original formula and its use illustrated in censusing singers of *Oecanthus niveus* in Mexico. The unmodified index departs widely from observed densities; the modified index does not.

## Key words

*Oecanthus*, census, density, acoustic, Southwood, listen

Aural detection is an indirect census method used to estimate the density of acoustically signalling animals, such as birds and insects (Gates & Smith 1972, Southwood & Henderson 2000).

In order to estimate the density of calling animals, Southwood (1978) and Southwood & Henderson (2000) proposed the "Petraborg" index. Misspelled by these authors, this should be called the 'Petraborg' index (see Petraborg *et al.* 1953).

The Petraborg Index is based upon a series of regularly spaced sampling pauses made by a listener. The density of singing animals (P.I.) is given by the following equation:

$$P.I. = \frac{\bar{h}}{L\pi r_a^2}$$

where  $\bar{h}$  = the average number of songs heard per sampling pause,  $L$  = the total number of listening pauses made, and  $r_a$  = the audibility radius.

As written this equation indicates:

$$P.I. = \frac{\sum_{i=1}^L h_i}{L^2\pi r_a^2}$$

That is, the number of singing animals is divided twice by the number of listening pauses ( $L$ ) made, which underestimates the true density of the animals producing the sounds. Therefore, we suggest a correction to the index (as originally proposed in Petraborg's paper and repeated in Southwood's book in its two editions (1978, 2000): we shall refer to this as the Modified Petraborg Index (*M.P.I.*):

$$M.P.I. = \frac{\sum_{i=1}^L h_i}{L\pi r_a^2} \quad \text{or} \quad M.P.I. = \frac{\bar{h}}{\pi r_a^2}$$

Our work group used both Petraborg indices, modified and unmodified, to calculate the density of male tree crickets, *Oecanthus niveus*, singing at a site in Central Mexico from January to December, 2005. The calling song of the males of this species is composed of five-pulse trains (chirps) each lasting  $\sim 0.1$  s, given at a regular rate of about 3/s at 22°C, with a carrier frequency of  $\sim 2.25$  kHz (Ponce-Wainer & Cueva del Castillo 2008). At the study site, singing activity takes place between 18:00 and 03:30 h, with the highest peak of activity recorded between 19:30 and 20:00 h (Pérez-Escobedo 2007).

This study was conducted in Pedregal de San Ángel Ecological Reserve (lat 19° 17' North, long 99° 11' West, 2300 m a.s.l.). Our measurements were made more comparable by employing the same single listener throughout the survey [this listener was H.M.P.-E.]: this avoided any errors arising in  $r_a$  due to different listeners. Audibility radius  $r_a$  was determined by establishing the distance at which our designated listener ceased to detect calling *O. niveus*: this distance was about 7 m. The error in  $r_a$  continues to be affected by variation in both vegetation density and chirp volume of each caller.

We obtained 25 listening-pause samples ( $L$ ), each 100 m apart, over two consecutive days each month between 18:00 and 20:00 in the evening. Each listening sample lasted three minutes: 15 of these were carried out the first day at one location, and 10 the following day at another location. The listener counted only the number of calling males, not the number of chirps.

To avoid disturbance during sampling, the actual presence of cricket singers was only verified following every sampling pause, by searching for and finding the singing males. The male songsters sing spaced within an aggregation or chorus, and each songster could be individually detected within a time interval of about 3 min. We also observed silent adult (satellite?) males perched near the singing male in ca 5% of our observations: 1-3 nonsinging males were within 1 m of a singing male.

The Petraborg index (*P.I.*) varied from  $3.5 \pm 0.6$   $s_{\bar{x}}$  to  $10.5 \pm 0.8$  ind/ha, whereas *M.P.I.* varied from  $87.0 \pm 15.2$  to  $262.4 \pm 20.1$  ind/ha (Table 1).

The *M.P.I.* values were a much better estimate of the mean density of crickets, more congruent with the real density of callers determined in the field: up to nine callers, 2.3 on average, were detected during each sampling pause in an audibility area of 153.9 m<sup>2</sup>. This is a mean density of males per 10,000 m<sup>2</sup> (hectare) of 150. It compares well with the monthly mean densities as determined by the *M.P.I.* (Table 1), but not with the monthly mean densities estimated by *P.I.* Estimation of male density using the *P.I.* is an unrealistic estimator.

## Acknowledgments

We thank Glenn Morris for valuable suggestions that improved the manuscript's quality, and Isael Victoria for field assistance. The Universidad Nacional Autónoma de México supported this work through a grant PAPIIT IN 216203.

## References

- Gates E.C., Smith W.B. 1972. Estimation of density of mourning doves from aural information. *Biometrics*. 28: 345-349.
- Petraborg W.H., Wellein E.G., Gunvalson V.E. 1953. Roadside drumming counts, a spring census method for ruffed grouse. *Journal of Wildlife Management* 17: 292-295.
- Pérez-Escobedo H.M. 2007. Variación espacial y temporal de la estructura poblacional de dos grillos del género *Oecanthus* (Orthoptera: Gryllidae) en la Reserva Ecológica del Pedregal de San Ángel. B.S. Thesis. Facultad de Ciencias, Universidad Nacional Autónoma de México, Mexico.
- Ponce-Wainer J.X., Cueva del Castillo R. 2008. Female mate choice and no detected predation risk in relation to the calling song of *Oecanthus niveus* (Gryllidae: Oecanthinae). *Annals of the Entomological Society of America* 101: 260-265.
- Southwood T.R.E. 1978. Ecological methods with particular reference to the study of insect population. Chapman and Hall, London.
- Southwood T.R.E., Henderson P.A. 2000. *Ecological Methods*. Blackwell Science, London.

**Table 1.** Comparison of mean density (No./ha) of tree crickets (*O. niveus*) in Pedregal of San Ángel Ecological Reserve, calculated by the Petraborg index (*P.I.*) and by [recommended] modified Petraborg index (*M.P.I.*). Data from January to December, 2005. Note that *M.P.I.* is *L* times higher than *P.I.* (*L* = 25).

Months	P. I.	M.P. I.
	(Mean $\pm$ s $_{\bar{x}}$ )	(Mean $\pm$ s $_{\bar{x}}$ )
January	5.0 $\pm$ 0.8	123.9 $\pm$ 19.4
February	10.5 $\pm$ 0.8	262.4 $\pm$ 20.1
March	10.1 $\pm$ 1.2	252.0 $\pm$ 29.2
April	6.0 $\pm$ 0.9	150.7 $\pm$ 22.8
May	5.5 $\pm$ 0.8	137.1 $\pm$ 19.2
June	4.3 $\pm$ 0.8	106.5 $\pm$ 19.8
July	4.8 $\pm$ 0.9	120.8 $\pm$ 21.9
August	3.5 $\pm$ 0.6	87.0 $\pm$ 15.2
September	4.8 $\pm$ 0.9	120.8 $\pm$ 21.8
October	7.8 $\pm$ 1.0	194.9 $\pm$ 25.8
November	5.4 $\pm$ 1.0	135.1 $\pm$ 24.7
December	4.8 $\pm$ 0.8	120.8 $\pm$ 18.9