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## First report on the density of the small-eared shrew, *Cryptotis nigrescens* (Eulipotypla: Soricidae) from Western Panama

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### RESUMEN

Los potenciales efectos que el cambio climático pudiese provocar en la estructura de las comunidades de especies montanas en el trópico, han incrementado el interés por conocer sobre su ecología actual desde diferentes perspectivas. Sin embargo, el tamaño pequeño de algunas especies parece haber causado que mamíferos como las musarañas hayan escapado del interés general de los investigadores en Mesoamérica. En este artículo, se reportan aproximaciones basadas en datos de campo sobre la densidad poblacional de musarañas de orejas pequeñas (*Cryptotis nigrescens*), en Panamá. Las musarañas fueron colectadas en un sistema de cuadrícula utilizando trampas vivas modelo Sherman en el Parque Internacional La Amistad; localidad que ofrece un escenario para desarrollar estudios sobre interacciones inter-específicas entre *C. nigrescens* y otros mamíferos pequeños. Se registró una densidad máxima de 19 individuos por hectárea en un solo día de captura y un promedio de 5.3 individuos por hectárea basado en los días que presentaron capturas; por lo cual se infiere que *C. nigrescens* es común en el área de estudio. Se considera imperativo estudiar la ecología de esta musaraña, la cual muestra una distribución restringida a los frágiles ecosistemas montanos, antes de que éstos desaparezcan.

### ABSTRACT

The potential effects of climate change on the community assemblage of tropical montane species have increased the interest in understanding these species' current ecology from several perspectives. Nonetheless, the inconspicuousness of some species may have promoted that groups of small mammals, such as shrews, have escaped the general interest of local researchers in Mesoamerica. Here field-based approximations are presented for the density of the Small-eared shrew (*Cryptotis nigrescens*) in Panama. Shrews were collected in a grid system using Sherman live traps at the Parque Internacional La Amistad, a locality that offers a scenario for developing studies of interspecific interactions between *C. nigrescens* and other small mammals. A maximum density of 19 individuals per hectare was registered in a single day, and an average of 5.3 individuals per hectare based on the days with effective captures; suggesting that *C. nigrescens* is common in the study area. It is considered imperative to study the ecology of this shrew, which is restricted to the fragile montane environments, before they disappear.

### PALABRAS CLAVES; KEY WORDS

Musaraña de orejas cortas, *Cryptotis nigrescens*, densidad, Panamá, América Central, pequeños mamíferos; Small-eared shrew, *Cryptotis nigrescens*, density, Panama, Central America, small mammals.

## INTRODUCTION

Understanding the spatio-temporal dynamics of species populations remains an important goal in ecology and is particularly fundamental for estimating the species' life-history evolution at several scales (Sutherland *et al.* 2013). Additionally, with the development of recent fields such as spatial distribution modeling, population dynamics becomes important for translating the growing number of published hypotheses that suggest the expansion, reduction or fragmentation of species distributions. Among several attributes, population density is particularly important as it is commonly used to understand ecological processes like competition and territoriality across several taxa (Fletcher 2007, Marshall *et al.* 2009, Vieira & Paize 2011). The potential effects of climate change on the community assemblage of tropical montane species have increased the interest for understanding such species' current ecology from several perspectives, as for example their inter- and intraspecific interactions, niche dimensions, and population dynamics (Buermann *et al.* 2011; Gasner *et al.* 2010). The contrasting reality, whatsoever, is a great deficit in taxonomical assignments and natural history descriptions for montane vertebrates in the Neotropics, particularly for the smallest species such as shrews.

The inconspicuousness of some of the smallest members of the Mesoamerican montane mammal community, the small-eared shrews (Genus *Cryptotis*), must be assumed as a primary cause for the relative paucity of publications on this group, which seems to have escaped the interest of local scientists in the Mesoamerican region. Within this genus, the *C. nigrescens* species complex, known to occur in the highlands of Costa Rica and western Panama at elevations above 800 m, still remains poorly understood from an ecological perspective (Woodman & Timm 1993; Samudio Jr. & Pino 2014). Especially in the northern Neotropics, shrews and other montane mammalian species face a growing pressure due the continuous habitat conversion of the fragile ecosystems in this region. In many areas across the region, as for example in Panama, this habitat conversion into croplands seems to be the rule. As a result, the small patchy-remnants of wild lands and water sources usually end up compromised by the deposition of pesticides (UNEP & IOMC 2009) and other chemicals; influencing the natural dynamics of the species populations.

A review of its conservation status indicated that *C. nigrescens* is presumed to have a large population across its distributional range from Costa Rica to Panama (Pino & Woodman 2008). However, the body of literature involving shrew trapping (Mulungu *et al.* 2008; McCain 2004; Barnett 1992; Woodman *et al.* 2012), exhibits a generalized tendency of using line-transect approaches or other methods that prevent the estimation of population densities, resulting mostly in descriptions of a relative trapping success. The purpose of this study is to provide field-based approximations for the density of *C. nigrescens*, a species that is restricted to fragile montane environments such as cloud forest and paramos in Costa Rica and Western Panama and for which only scarce information is available. As part of a larger expedition investigating the social organization of Neotropical singing mice (*Scotinomys*), the author documented basic spatio-temporal information for the small-eared shrew, *Cryptotis nigrescens*, which were caught in a grid-trapping system during May-August of 2004 in Western Panama.

## MATERIAL AND METHODS

The grid-system was located at 2,270 meters (a.s.l.) within the Parque Internacional La Amistad (PILA), at Las Nubes in Chiriqui Province (8.8953 N, 82.6187 W). Shrews were caught in a 60 x 70 meters grid-trapping system (0.42 ha), where each grid-cell measured 10x10 meters. Two Sherman traps (5 x 6 x 16 cm) were located in each cell corner for a total of 112 traps placed on the ground. Traps were baited with a mixture of peanut butter and vanilla-oats, a common bait used for trapping small mammals in the Neotropics (Hice & Velazco 2013). The traps were opened from 6:00 a.m. to 1:00 p.m. Shrews were identified in the field aimed by an illustrated mammal field guide and morphological data from literature (Reid 1997; Pine *et al.* 2002; Goodwin 1954), and released without marking them. The online platform Math is Fun (Pierce 2015) was used to create figure 3, showing the extent to which tools in this K-12 website can be applied to. Shrews were not marked when captured, this prevented to make estimations based on a capture-recapture model; Due to this reason, daily densities were estimated dividing the number of shrew captured by the area of the grid (i/ha).

## RESULTS

A total of 47 shrew captures were recorded within the trapping-grid. Figure 2 shows the temporal distribution of these captures, but illustrating only those days when shrews were recorded in traps. Spatially, the raw data from individual trap points suggests that population densities range from 2.4 to 19.0 i/ha, with an average of 5.3 i/ha. Since individuals were not marked, these estimations are based on the number of individuals caught per day. Temporally, shrew trapping yielded an average capture of 2.2 i/day. The spatial distribution of the eight shrews trapped on the day with the greatest capture success, plotted in Fig. 3, shows that the individual trapping events were not clustered together in the grid. The minimum convex polygon formed by enveloping the successful traps (Figure 3) delimits an area of 1,450 m<sup>2</sup> (0.145 ha), thus yielding as the maximum density of shrews recorded in this study some 5.52 i/ha.

*C. nigrescens* was caught in sympatry with the singing mouse *Scotinomys xerampelinus*, a species with which it shares a similar size (<20 g), diet (insectivore) and activity rhythm (diurnal), as well as probably other ecological requirements.

## DISCUSSION

*Trapping.* Although the trapping setting was adequate for singing mice experiments, the author managed to gather some data that may contribute to the scarce literature of shrews from Panama. Proper estimations of population densities require robust field study designs that incorporate spatial and temporal elements with the individual capture-mark-recapture component. Nonetheless, the intention of this article is to report preliminary observations on shrew densities, as a collateral result obtained in a different project. For this reason, capture-mark-recapture in shrews was not performed. Shrew-trapping success using Sherman live traps has been questioned experienced by mammalogists, who achieved better results using pitfall traps (Pacheco *et al.* 2006; Woodman & Timm 1993). Although no pitfall traps were used in this grid system, the author had a positive experience trapping small-eared shrews using the small Sherman live traps, and would recommend their use for the study of shrews in the tropics. While the trapping system was designed for *S. xerampelinus*, a larger species weighing approximately 13-15 g (Blondel *et al.* 2009; Pasch *et al.* 2013), I noticed during the preliminary trapping sessions that the trap triggers required to be finely adjusted if they were to respond to lighter species such as shrews weighing 3.0-7.5 g (Woodman 2000). Setting the Sherman traps with the same trigger sensibility for all small mammals may explain the general absence or low representation of shrews in published mammal inventories in the Neotropics. The differences in trap-size used could also be an argument for the effective detection of shrews experienced by mammalogists.

*Density.* Assessments of population densities are common for some small mammal groups in the tropics, especially for rodents, but particularly scarce for shrews. The estimations presented here 5.3 i/ha, are preliminary approximations for *C. nigrescens* in the cloud highlands of western Panama. The author recognize that more robust efforts are required for a better understanding of the densities and population dynamics of this species. The taxonomically closest shrew species for which population densities have been published is *Cryptotis parva*, with 32 i/ha (Frantz 1972), 34.6 and 43.2 i/ha (Andrews 1974), estimated from different locations in North America. Direct comparisons with the densities reported herein for *C. nigrescens* may thus be hampered both by the differences in geographical and/or ecological context as well as in the respective trapping protocols. Whether the population density of *C. nigrescens* is high or low needs to be determined in further studies. However, trapping events of shrews from outside the grid were also frequent, implying that *C. nigrescens* is common in the study area.

Daytime trapping helped discriminating shrews from nocturnal species; but *S. xerampelinus*, a diurnal species was also caught along with *C. nigrescens*, suggesting that interspecific interactions may mediate the use of spatial and/or resource niches influencing the population dynamics. For example, field data on the Ecuadorian shrew *C. montivaga* showed that its co-occurrence with two more species that also feed on insects promotes interspecific interactions that lower the abundance of *C. montivaga*, due to competition for resources (Barnett 1992). Thus, considering the co-occurrence of *C. nigrescens* with *S. xerampelinus*, interspecific density dependence might be assumed and should be addressed in future studies.

*Implications.* The very short time window of one trapping day (7 hours) with eight individuals caught showed that shrews were dispersed in the grid (Figure 3). This raises questions about intraspecific interactions in *C. nigrescens* that mediate individual encounters, but little is known about this behavior in shrews. The singing mouse *S. xerampelinus* was inferred to occur in higher densities, i.e., with 28 and 62 ind/ha, in the same grid in 2003 and 2004, respectively (Blondel *et al.* 2009). These two species share important spatio-temporal dimensions, such as diurnal activity (Pasch & Pino 2013) and the fact that both species feed on insects (Hooper & Carleton 1976). This condition may have led to the evolutionary development of strategies to avoid competition. Singing mice, for example, are known to vocalize to mediate competitive interspecific interactions (Campbell *et al.* 2014; Pasch *et al.* 2013). However, there is a lack of detailed information on the vocalization of *C. nigrescens*, which precludes any assumptions in this regard. Shrew vocalization patterns have been described for *Blarina brevicauda*, *Cryptotis parva* and *Suncus murinus* (Gould 1969), *Sorex isodon* (Skarén 1979); and more recently also for *S. murinus* (Schneiderová & Zouhar 2014) and *Diplomesodon pulchellum* (Volodin *et al.* 2015), suggesting that there is a great potential for developing exploratory studies on vocalization of *C. nigrescens* and further studies on interspecific vocal signaling between singing mice and *C. nigrescens* in this area.

The fast pace at which montane landscapes change in southern Central America may cause the progressive diminution and eventual disappearance of the populations of *C. nigrescens*, reducing their overall genetic pool even before we record the basics of their ecology. For this reason, the author recalls the urgent necessity of studying the intriguing natural history of shrews in their natural environments before both disappear.

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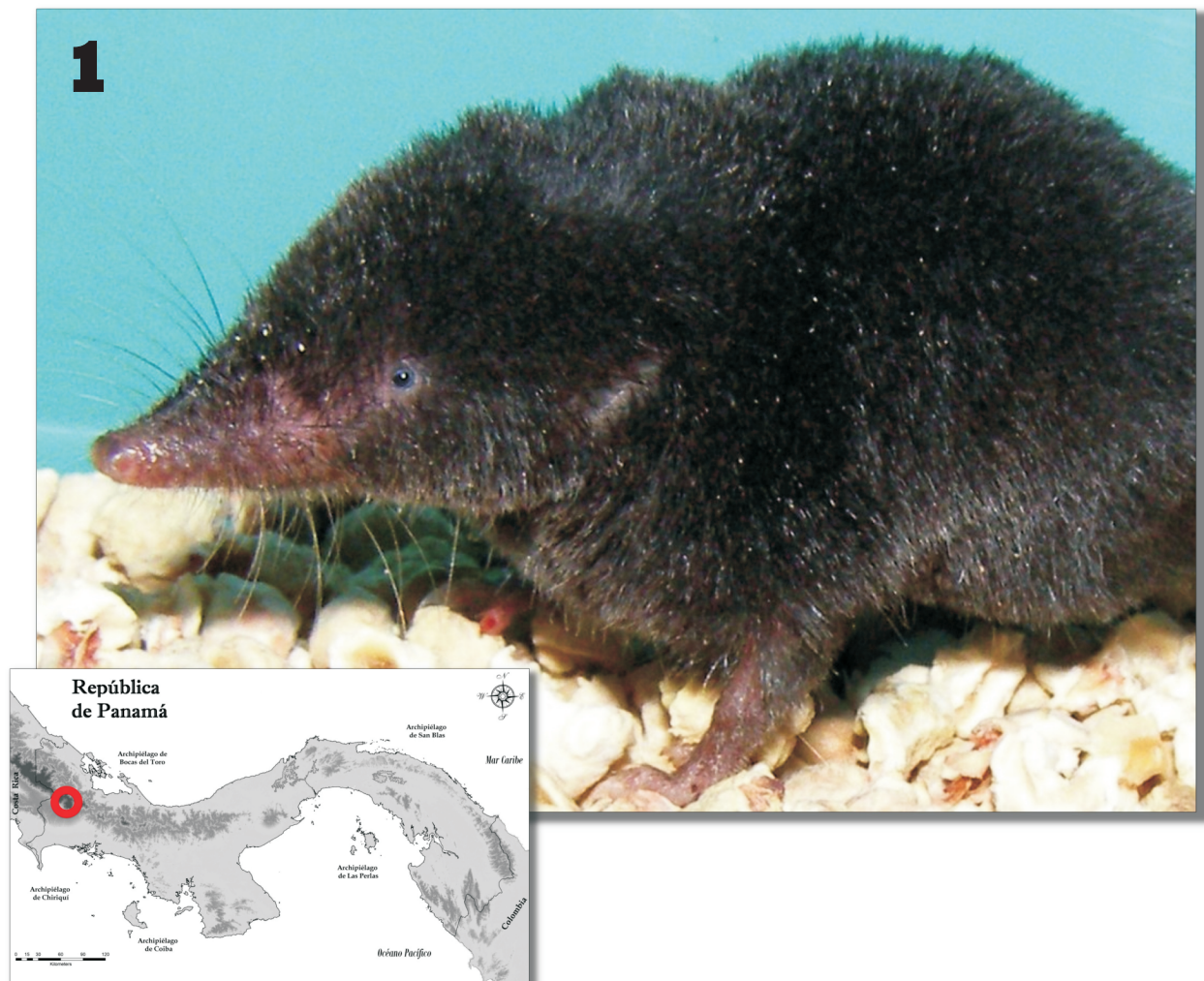
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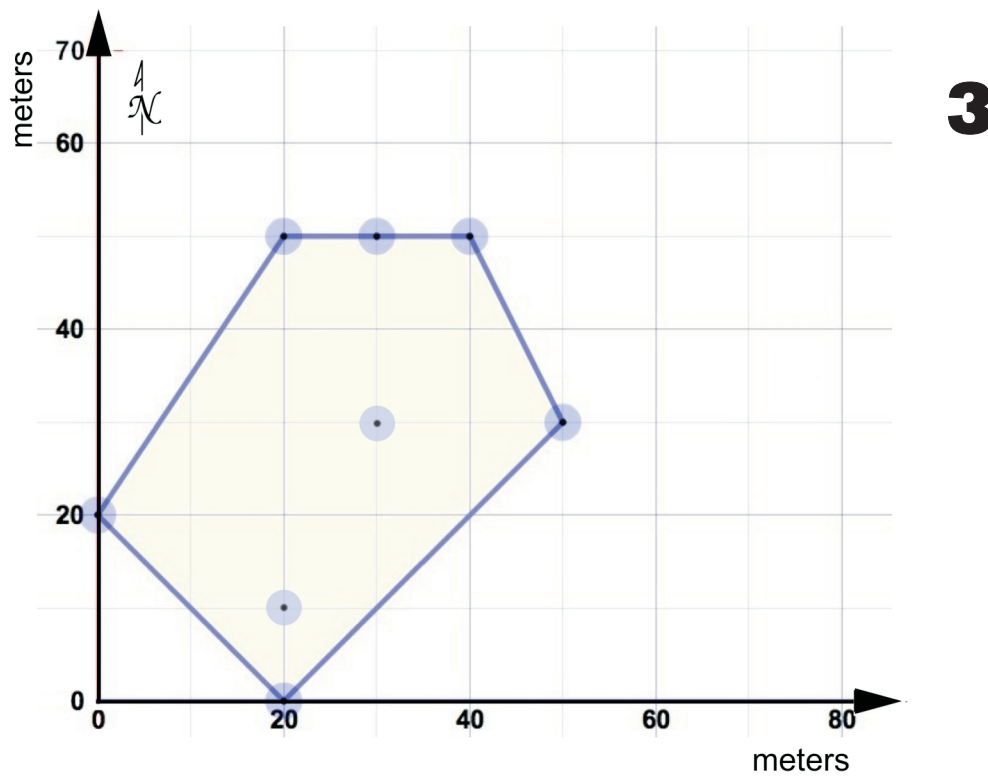
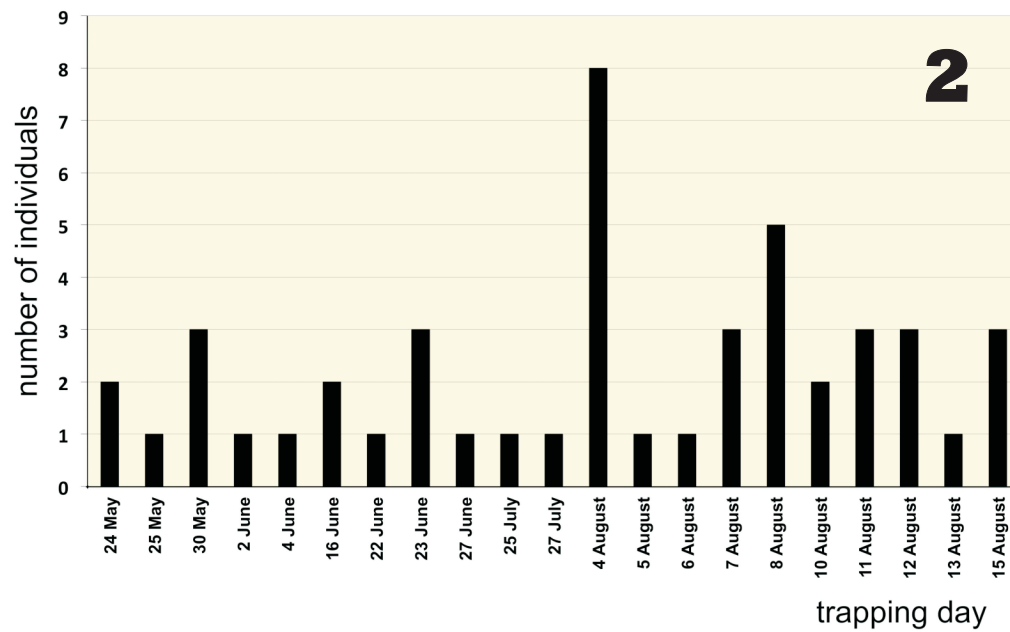
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**Figure 1.** An individual of the Small-eared shrew, *Cryptotis nigrescens*, captured at Las Nubes (approximate location indicated by red circle in inset map), Parque Internacional La Amistad (PILA),



**Figures 2-3.** **Fig. 2.** Number of shrews captured in the grid system on successful trapping days within the trapping season. **Fig. 3.** Minimum convex polygon enveloping the spatial locations of eight shrews caught in the grid trapping system during one day, August 4th 2004. The polygon delimits an area of 145 square meter (0.0145 ha).