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PROPOSAL FOR A TECHNOLOGICAL OFFER IN SUSTAINABLE HIGH MOUNTAIN LIVESTOCK IN COLOMBIA, USING BIO-RECYCLER DUNG BEETLES

ABSTRACT: From the Humboldt Institute, research is being carried out that relates the diversity and functional activity of bio recycling dung beetles (Scarabaeinae) and the benefits for livestock production, with the aim of designing a proposal for a technological offer in sustainable livestock. The research pilot is carried out in the Chuguaca ranch; Norman cattle farms for dairy production in the central Andean zone of Colombia. The diversity of beetles was characterized by sampling with baited traps, and with terrariums the life cycle of three species was monitored: *Homocopris achamas*, *Ontherus brevicollis* and *Onthophagus curvicornis*. Six species of Scarabaeinae have been recorded, three of these with high activity in pastures. The non-use of Ivermectin has notably increased the activity of the beetles on the manure. The interest and investigative curiosity that the project has aroused in owners, workers, technicians and visitors to the farm, is essential for success in the path of a more environmentally friendly livestock production.

KEYWORDS: Dairy production, Scarabaeidae, Sustainability.

PROPOSTA DE OFERTA TECNOLÓGICA EM PECUÁRIA SUSTENTÁVEL DE ALTA MONTANHA NA COLÔMBIA, USANDO BESOUROS DE ESTRUME BIO-REICLADORES

RESUMO: A partir do Instituto Humboldt, estão sendo realizadas pesquisas que relacionam a diversidade e a atividade funcional dos escaravelhos biorrecicladores (Scarabaeinae) e os benefícios para a pecuária, com o

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objetivo de desenhar uma proposta de oferta tecnológica em pecuária sustentável. O piloto de pesquisa foi realizado na fazenda Chuguaca; Fazendas de gado normando para produção de leite na zona andina central da Colômbia. A diversidade de besouros foi caracterizada por amostragem com armadilhas com isca, e com terrários foi monitorizado o ciclo de vida de três espécies: *Homocopris achamas*, *Ontherus brevicollis* e *Onthophagus curvicornis*. Seis espécies de Scarabaeinae foram registradas, três de lâs com alta atividade em pastagens. A não utilização de ivermectina aumentou notavelmente a atividade dos besouros no estrume. O interesse e curiosidade investigativa que o projeto tem despertado nos proprietários, trabalhadores, técnicos e visitantes da quinta, é essencial para o sucesso no caminho de uma produção pecuária mais amiga do ambiente.

PALAVRAS-CHAVE: Escarabeídeo, Produção de leite., Sustentabilidade.

PROPUESTA DE OFERTA TECNOLÓGICA EN GANADERÍA SOSTENIBLE DE ALTA MONTAÑA EN COLOMBIA, UTILIZANDO ESCARABAJOS COPRÓFAGOS BIO-RECICLADORES

RESUMEN: Desde el Instituto Humboldt, se adelanta investigación que relaciona la diversidad y la actividad funcional de los escarabajos coprófagos bio-recicladores (Scarabaeinae) y los beneficios para la producción ganadera, con el objetivo de diseñar una propuesta de oferta tecnológica en ganadería sostenible. El piloto de investigación se realiza en la ganadería Chuguaca; fincas de ganado normando para producción lechera en la zona andina central de Colombia. La diversidad de escarabajos se caracterizó con muestreo con trampas cebadas, y con terrarios se hace seguimiento al ciclo de vida a tres especies: *Homocopris achamas*, *Ontherus brevicollis* y *Onthophagus curvicornis*. Seis especies de Scarabaeinae han sido registradas, tres de estas con alta actividad en los potreros. El no uso de la Ivermectina ha aumentado notoriamente la actividad de los escarabajos sobre el estiércol. El interés y curiosidad investigativa que ha despertado el proyecto en dueños, trabajadores, técnicos y visitantes de la finca, es fundamental para el éxito en el camino de una producción ganadera más amigable con el medio ambiente.

PALABRAS CLAVES: Escarabajo, Producción láctea, Sostenibilidad.

Recently, a group of insects, the coprophagous beetles (Scarabaeinae), has made news. Besides multiple scientific papers, different articles, and websites highlight dung beetles and their relationships and their effects on livestock production systems (GEWIN, 2019; THOMAS 2020). For decades, in countries such as Australia and more recently in New Zealand, species of dung beetles have been introduced into pastures for the recycling of bovine excrement, and dung beetles can be purchased for use to improve manure management in pastures (DOUBE, 2008; FORGIE et al., 2018).

Many projects worldwide promote the importance of this group of insects for the control of flies and other parasites, which translates into improved animal welfare (LOSEY; VAUGHAN, 2006). Dung beetles promote nutrient recycling and improve soil health, and more recently, their contribution to the reduction of greenhouse gases, especially methane, has also been recognized (SLADE et al., 2016).

In Latin America, livestock production is changing. In Colombia, the sustainable livestock project, led by CIPAV (Centro para la Investigación en Sistemas Sostenibles de Producción Agropecuaria), and other institutions, involved in the assessment of the diversity of beetles on demonstration farms, in different areas of Colombia, and opened the way for research on the association of these insects with the livestock production sector (GIRALDO et al., 2018). Research carried out by the Humboldt Institute shows the benefits of conserving biodiversity within production systems (Andrade et al. 2018). Likewise accumulated expertise in research in high mountain forests, and on coprophagous beetles, facilitate the design of a proposal for a technological package in sustainable livestock that relates the functional activity of dung beetles and the benefits for high mountain livestock production.

Coprophagous beetles are Bio-recyclers par excellence; they maintain the flow of energy and the cycling of nutrients from the pasture surface to

lower levels, transforming and clearing livestock excreta from pastures (MEDINA et al., 2019). The main objective of the project was to evaluate the effect of diversity and functional activity of dung beetles on pasture soil health and the benefits for a sustainable livestock production.

The Chuguaca livestock ranch, in an important area of conservation of Andean forests, was chosen to carry out the experimental sustainable livestock pilot project. Chuguaca is formed of various farms, between 2,700 and 3,000 m above sea level (masl), which add up to approximately 400 hectares, where Norman cattle breeding and efficient milk production is maintained under practices that preserve the natural environment. These farms protect a humid forest with native and endemic plant species, allocate considerable areas for restoration, and adequately manage reservoirs and water resources (Figure 1). Chuguaca livestock is moving towards more sustainable production, and without mechanization nor use of

chemical pesticides. Use of Ivermectin [a veterinary drug that has been proven affect the dung beetles' populations (VERDU et al., 2018) as purge was suspended nearly three years ago. All these actions were expected to help maintain soil health and the diversity of soil fauna, including dung beetles. The study was expected to verify this effect.

Using baited pitfall traps, the diversity of dung beetles on the farms, including forest and pastures were sampled and monitored from September 2020 to April 2022. Either six or seven traps were set in each sampling event. The traps were left exposed for 24 hours and the beetles were captured alive. Some individuals were selected for the breeding pilot established in one of the Chuguaca farms, and the others were released into their habitat after the sampling. In addition to the sampling with traps, manual search of beetles and signs of their activity in the manures in different pastures of the farms was carried out.

Figure 1. View of Chuguaca farms.



Photo by Juan Ramón Giraldo (2020).

The life cycles of the three most common high Andean species, i.e: *Homocopris achamas*, *Ontherus brevicollis*, and *Onthophagus curvicornis*, were followed in rearing terrariums consisting of 15L buckets previously cut in half to facilitate subsequent revisions. With the help of a Chuguaca worker, a sloping field was also organized for the observation and monitoring the life cycle of the digging

species, *H. achamas* (Figure 2). The participation of farm workers was key in the choice of methods and the monitoring of the reproductive cycle of the beetles. Additionally, a display case was adapted as a demonstration terrarium, allowing observation of the activity of the beetles on the dung, as well as the tunnels and galleries that the beetles make when burying the dung for feeding and reproduction.

Figure 2. Sloping field excavations for *Homocopris achamas* galleries at Chuguaca farm.



Photo by Juan Ramón Giraldo (2020).

According to these sampling events, the dung beetle community of the Chuguaca farms consist of a total of six species from the subfamily Scarabaeinae; three species more than in a sampling completed five years ago on the Chuguaca farms on a Humboldt Institute's expedition (NEITA-MORENO 2017). Of the six species, three (*Canthidium* sp 30H., *Ontherus brevicollis*, and *Dichotomius inachoides*) were distributed in forest and three

others, the same registered in 2017, *Homocopris achamas*, *Uroxys coarctatus*, and *Onthophagus curvicornis*, were found in pastures. Of these, *U. coarctatus* and *O. curvicornis* are widely distributed in pasture ecosystems and particularly associated with cow dung in open and disturbed Andean areas. These species can register up to 300 individuals per trap, as was the case in a milk production silvopastoril system in Boyacá

Department, Colombia (ESCOBAR et al., 2020, MEDINA, 2022). *U. coarctatus* is an endemic species restricted to the central Andean zone of Colombia distributed from 2,500 to 2,800 masl, while *O. curvicornis* is more widely distributed from 1,000 to 2,800 masl. *O. brevicollis* is associated with forest, and is not found in the pastures, but this species has been reared under laboratory conditions with cow dung.

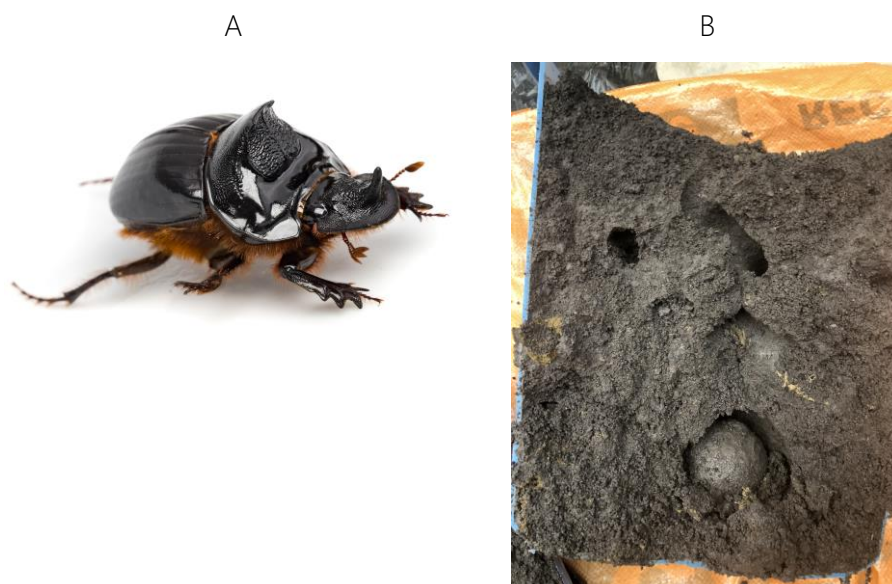
When examining the activity in the terrariums and the sloping field, it was possible to differentiate the activity of beetles on the manure and the external appearance after the activity of burying. In the case of *O. curvicornis* the adults bury the dung to between 10 and 40 cm deep, and when there is an intensive activity, the manure remains shredded. In the revisions in pastures, the adults were observed within the manure, and small holes in the soil under the manure were detected. *O. brevicollis* was not found in the manure in pastures, but was followed in the terrariums, where the species digs holes and buries the cow dung

efficiently. In the case of *Homocopris achamas*, a large (3,2 – 4,2 cm, n = 15) and efficient digger species, the holes in the ground and the excavated dark soil next to the manure are notable on pastures. *H. achamas* have been observed in high Andean mountains in three departments of Colombia: Boyacá, Cundinamarca, and Nariño, and also in Ecuador (MARTÍNEZ-REVELO; LOPERA-TORO, 2014; ALVARADO; ARIAS, 2015, CHAMORRO et al., 2018). Although this species is distributed in high Andean ecosystems, associated with cow and horse dung (ALVARADO; ARIAS, 2015), what was found in this project is that this species is rare on the farms, documented only on farms with considerable portions of forest and where Ivermectin has never been used or where use has been discontinued. The adults of *H. achamas* were not found manually on the ground revisions, but were captured in traps; not as abundant as *U. coarctatus*, generally two individuals per trap on average (N=15). In an experiment with terrariums under laboratory conditions,

two *H. achamas* buried 46 % percent of dung supplied. When this species is present, normally between 40 and 70 % of the supplied manure is processed; over time beetle activity helps to disintegrate the entire manure mass; the opposite is seen in the manures on farms where this species is absent: 45 days after the cattle enter the pasture, the manures are observed intact and stiff and without activity of beetles or other soil fauna. (C.A. Medina unpublished data).

Two months after the terrariums were established, the two halves of the buckets were separated and the activity of beetle's underground was observed. *O. curvicornis* and *O. brevicollis* made galleries between 30 and 40 cm deep, and establish between one and three nest masses without parental care. *H. achamas* made its gallery at the bottom of the bucket, and a single nest mass with an egg on top was observed (Figure 3).

Figure 3. View of one of the halves of the terrarium, the nest ball of *Homocopris achamas* can be seen at the bottom of the bucket.



A. *Homocopris achamas* B. View of one of the halves of the terrarium, the nest ball of *H. achamas* can be seen at the bottom of the bucket

On the sloping field, intense activity of *H. achamas* was observed. It was possible to follow the zigzagging galleries under the grass, and nest masses were found up to 70 and 100 cm deep, where the rocky horizon begins. Large portions of manure were observed along the galleries and deep in the soil. Details of the life cycles of the three species are still in progress at the Chuguaca farm, and replicas of the breeding of these three species are ongoing under laboratory conditions to obtain more information on the biology of the beetles and to develop a standard rearing methodology.

Numerous favorable changes have occurred on the Chuguaca cattle ranch since the arrival of the dung beetle project. Monitoring how discontinuance of ivermectin use has led to a marked increase beetle activity on cow manure. An important aspect to highlight is the interest and investigative curiosity that the project has stimulated in owners, workers, technicians, and visitors to the farms.

Being able to observe first-hand the biology and benefits of this group of insects in livestock production has been a positive result in the farm personal's increasing knowledge, which translates in improved research communication and specific conservation actions on the farms (SÁENZ, 2021a). The same was also seen in the science participative workshop "Escarabaton", organized as part of the project's socialization; a significant impact on producers and trade associations was evidenced (SÁENZ 2021b).

The project is still in progress. Additional Andean cattle ranches with different types of management are being evaluated to better understand how the differences in livestock production management affect biodiversity and how we can use dung beetles as indicators of "environmentally friendly" milk and meat production. Variables such as the proportion of forest in relation to pastures that are left on the farms, as well as the frequency and type of

veterinary purges, mechanization of soil, and pesticide or other chemical input use, are being considered. So far, the results show that, jointly with the producers, dairy companies, and national livestock associations, it is possible to build a path towards sustainability, with the implementation of strategies that improve the environmental conditions of the farm and the search for clean production or organic seals.

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