

Cotton rat (*Sigmodon toltecus*) as part of the diet of the Neotropical otter (*Lontra longicaudis annectens*)

Rata algodónera (*Sigmodon toltecus*) como parte de la dieta de la nutria neotropical (*Lontra longicaudis annectens*)

Laura Elena Vázquez-Maldonado^{1*}, Yolanda Hortelano-Moncada², Paul Jafet Berges-Cervera¹, Alberto Delgado-Estrella¹,
and Julieta Vargas-Cuenca²

¹Facultad de Ciencias Naturales, Campus III, Universidad Autónoma del Carmen. Av. Central s/n, Fraccionamiento Mundo Maya, C. P. 24115. Ciudad del Carmen, Campeche, México. E-mail: lauvamaster@gmail.com (LEV-M); jafetberges@gmail.com (PJB-C); delgadoestrella@gmail.com (AD-E).

²Colección Nacional de Mamíferos, Pabellón Nacional de la Biodiversidad, Departamento de Zoología, Instituto de Biología, Universidad Nacional Autónoma de México. Circuito Cultural, Ciudad Universitaria, C. P. 04510. Ciudad de México, México. E-mail: yolahm@ib.unam.mx (YH-M); jvargas@ib.unam.mx (JV-C).

*Corresponding author

There are few records of rodents in the diet of *Lontra longicaudis annectens* in México; only 2 references report the species. The objective of this note was to analyze the feeding habits of the Neotropical otter in Las Coloradas Lagoon, adjacent to the Palizada River, Campeche, and report the occasional consumption of cotton rats (*Sigmodon toltecus*). A distance of 6.63 km was traveled in a boat with an outboard motor along the west side of the lagoon (2.21 km / 2017–2018 climate season). Spraints and food remains from feeding sites were collected. Subsequently, the percentage of occurrence (PO) of the prey species consumed was determined. Ten zoological groups were identified from 176 spraints and 4 feeding sites: fish had the highest PO (36.74 %), followed by gastropods (26.17 %), prawns (11.58 %), crabs (8.56 %), insects (8.05 %), reptiles (5.37 %), birds (2.85 %), mammals (0.34 %), and bivalves and isopods (0.17 % each). Two skulls and 2 mandibles of *S. toltecus* were recorded in the 2018 dry season. Ten of the 14 species of cotton rats, *Sigmodon*, are recognized in México, of which 1 species (*S. toltecus*) is reported for the state of Campeche. This note reports the first record of rodent predation by *L. l. annectens* in the river-lagoon systems of Campeche. This occasional record expands the trophic spectrum of the Neotropical otter and the distribution of *S. toltecus* in the Laguna de Términos Natural Wildlife Protection Area (APFFLT, in Spanish) and the state of Campeche.

Key words: Cotton rat; eating habits; Laguna de Términos Natural Wildlife Protection Area; Neotropical otter.

En México existen pocos registros de roedores en la dieta de *Lontra longicaudis annectens*, sólo hay 2 referencias con especies. El objetivo de esta nota fue analizar los hábitos alimentarios de la nutria neotropical, en la laguna Las Coloradas, adyacente al río Palizada, Campeche y evidenciar el consumo ocasional de rata algodónera (*Sigmodon toltecus*). Se recorrieron 6.63 km en una embarcación con motor fuera de borda en el borde poniente de esta laguna (2.21 km / temporada climática 2017-2018). Se colectaron heces y comederos, determinando el porcentaje de aparición (PA) de las especies presas consumidas para su identificación. De 176 heces y 4 comederos se identificaron 10 grupos zoológicos: los peces presentaron el mayor PA (36.74 %), seguido por gasterópodos (26.17 %), langostinos (11.58 %), cangrejos (8.56 %), insectos (8.05 %), reptiles (5.37 %), aves (2.85 %), mamíferos (0.34 %), bivalvos e isópodos (0.17 %, respectivamente). En la temporada de secas (2018), se registraron 2 cráneos y 2 dentarios de *S. toltecus*. En México se reconocen 10 de las 14 especies de ratas algodóneras, *Sigmodon*, de las cuales se conoce 1 especie para el estado de Campeche (*S. toltecus*). Este es el primer registro de depredación de roedores por parte de *L. l. annectens* en los sistemas fluvio-lagunares de Campeche. Este registro ocasional, amplía el espectro alimentario de la nutria neotropical y la distribución de *S. toltecus* dentro del Área de Protección de Flora y Fauna Laguna de Términos (APFFLT) y del estado.

Palabras clave: Área de Protección de Flora y Fauna Laguna de Términos; hábitos alimentarios; nutria neotropical; rata algodónera.

© 2024 Asociación Mexicana de Mastozoología, www.mastozoologiamexicana.org

The feeding habits of the Neotropical otter, *Lontra longicaudis annectens* (Major, 1897), are generalistic and varied, so it is at the top of the food web of riparian ecosystems ([Macías-Sánchez and Aranda 1999](#)). It is an opportunistic predator whose diet includes a wide range of species available in its habitat ([Gallo-Reynoso et al. 2008](#)), so this species is considered key to the study of these ecosystems ([Rheingantz et al. 2017](#)). In México, the consumption of some mammals by *L. l. annectens* has been documented; however, these mammal

preys were identified at the specific level only in 2 studies, one by [Gallo-Reynoso \(1997\)](#) in the Sierra Madre del Sur, Chiapas, and the other in the Bavispe-Yaqui River, Sonora ([Rangel-Aguilar and Gallo-Reynoso 2013](#)).

Although efforts have been made to know the feeding habits of the Neotropical otter in several river-lagoon systems in the state of Campeche, the mammals included in its diet have not been recorded at the species level. In the lagoon La Lagartera (adjacent to the Palizada River),

[Mariano-Mendoza et al. \(2022\)](#) recorded mammal hair and bone and muscle fragments. However, these could only be identified at the class level, with a percentage of occurrence of 4.0 %, because the material found did not allow identification at the species level. In La Sangría Lagoon (adjacent to the Palizada River), [Vázquez-Maldonado and Delgado-Estrella \(2022\)](#) identified rodents at the order level, with a percentage of occurrence of 6.84 %. In the present work, we considered it important to identify the mammals found in the diet of the Neotropical otter at the species level and describe some ecological aspects in the Las Coloradas Lagoon, Palizada, Campeche.

Las Coloradas Lagoon, located between 18° 19' 58.86" and 18° 20' 53.07" N and between 91° 20' 24.23" and 91° 54' 15.76" W, is a water body adjacent to the Palizada River, one of the main branches of the Usumacinta River Delta, which is part of the Palizada-Del Este River-Lagoon Deltaic System ([Coll de Hurtado 1975](#); Figure 1 a-d). Las Coloradas Lagoon is located within the Laguna de Términos Natural Wildlife Protection Area (APFFLT, in Spanish), Campeche, México.

The west side of the lagoon is covered predominantly by riparian mangrove mainly composed of black mangrove (*Avicennia germinans*), with red mangrove (*Rhizophora mangle*) and, to a lesser extent, white mangrove (*Laguncularia racemosa*; [Jardel et al. 1987\); wetland vegetation dominates in the east side, with associations of wetland species locally called *popal* \(*Thalia geniculata* and *Calathea lutea*\) and reeds \(*Cladium jamaicense* and *Typha augustifolia*; \[Coll de Hurtado 1975\]\(#\)\).](#)

Fieldwork was carried out during the 3 climatic seasons that characterize the region: the rainy season and "nortes" (winter storm) season in 2017 and the dry season in 2018. In total, 6.63 km were traveled, 2.21 km along the western edge of Las Coloradas Lagoon in each climatic season. Surveys were traveled aboard a boat of 7.6 m in length (IMEMSA) with an outboard engine (60 HP). During these surveys, indirect evidence (latrines, spraints, feeding sites or sites where prey remains are found, burrows, vocalizations, footprints, genital exudates) was recorded that confirmed the presence of *L. l. annectens* in the study area. The spraints and food remains found at feeding sites were collected in self-sealable bags labeled with the date, collection site, sample number, and GPS-referenced geographic coordinates (GARMIN map 78s). In the laboratory, the samples were washed and dried, and the non-digestible components were analyzed following the method of [Vázquez-Maldonado and Delgado-Estrella \(2022\)](#). The percentage of occurrence (PO) of each prey was calculated according to the method of [Macías-Sánchez and Aranda \(1999\)](#), and the species richness and its distribution in the study area were determined. During this analysis, 2 skulls and 2 mandibles of rodents were found, which were identified at the species level using taxonomic keys ([Álvarez-Castañeda et al. 2015](#)) and by comparison with voucher specimens deposited in the National Collection of Mammals (CNMA) of the *Pabellón Nacional de la Biodiversidad* (National Biodiversity Hall), Institute of Biology, Ciudad Universitaria, Universidad Nacional Autónoma de México (UNAM), México City, México.

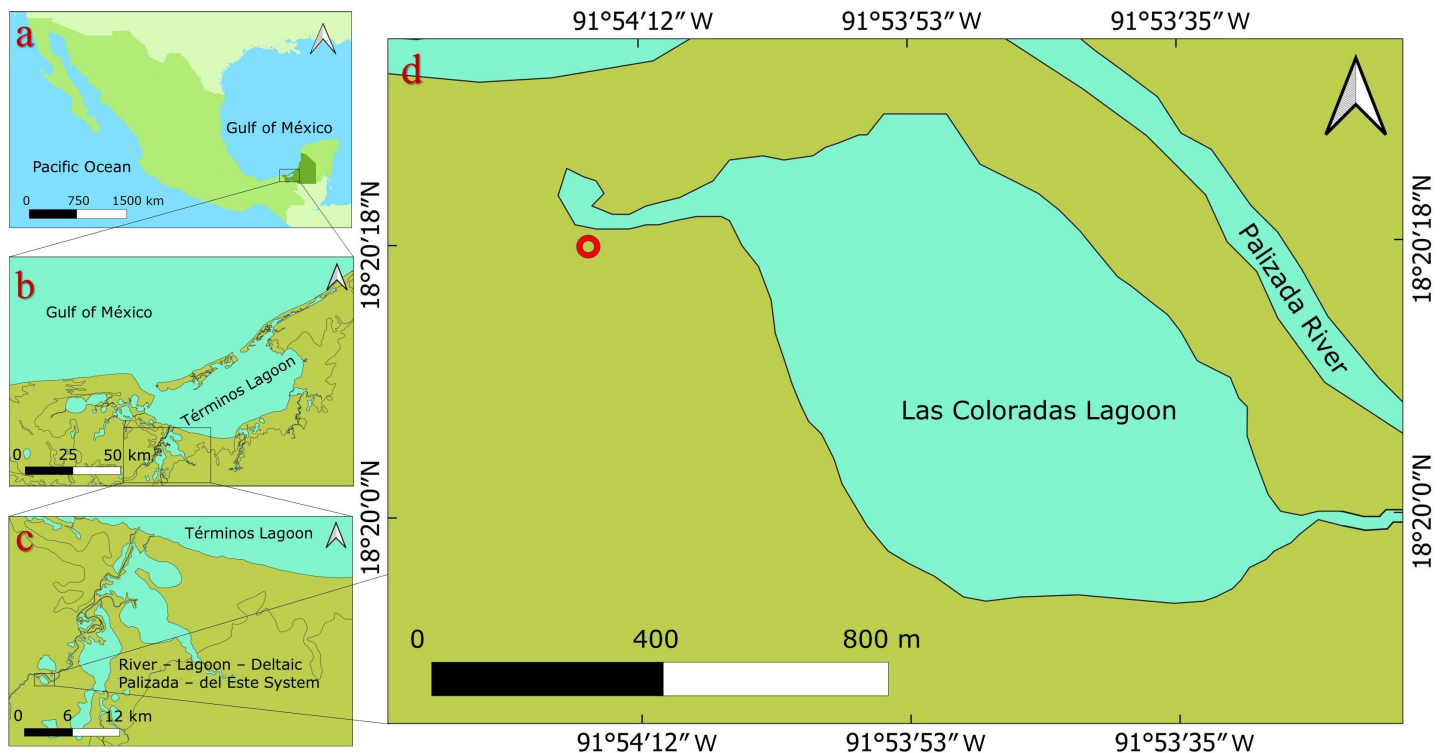


Figure 1. Geographic location of the study area. a) State of Campeche, south of the Gulf of México; b) demarcation of the River-Lagoon-Deltaic Palizada-del Este System; c) Las Coloradas Lagoon, adjacent to the Palizada River. The red circle indicates the geographic location of the spraint of *Lontra longicaudis annectens* collected in the 2018 dry season that contained the bone material of *Sigmodon toltecus*.

A total of 176 spraints and 4 feeding sites were analyzed from 2017 to 2018. Ten main zoological groups were identified; fish had the highest percentage of occurrence (PO; 36.74 %), followed by gastropods (26.17 %), prawns (Decapoda: Palaemonidae, 11.58 %), crabs (Decapoda: Brachyura, 8.56 %), insects (8.05 %), reptiles (5.37 %), birds (2.85 %), mammals (Rodentia, 0.34 %), and bivalves and isopods (0.17 % each).

In the 2018 dry season, we recorded the highest number of identifiable taxonomic groups (9 groups, $Z = 32$). In this season, we found 2 skulls and 2 mandibles of the cotton rat, *Sigmodon toltecus*, contained in a spraint located on the roots of a fallen trunk on the northwest shore of Las Coloradas Lagoon (18° 20' 18.0" N, 91° 54' 12.7" W; Figure 1d). These bone structures were deposited in the National Mammalian Collection (CNMA) with catalog numbers 50313 and 50314 (National Biodiversity Hall, México City, México).

Fourteen species of cotton rats of the genus *Sigmodon* are recognized worldwide (Lessmann et al. 2011; Pardiñas et al. 2017; MDD 2023); of these, 10 are recorded in México according to Pardiñas et al. (2017): *S. alleni*, *S. arizonae*, *S. fulviventer*, *S. hirsutus*, *S. hispidus*, *S. leucotis*, *S. mascotensis*, *S. ochrognathus*, *S. toltecus*, and *S. zanjonensis*.

Until recently, *S. toltecus* was assigned as a subspecies (*S. hispidus toltecus*), but molecular studies determined large genetic divergences with other subspecies, so it was raised to the species level (Peppers et al. 2002). This species is distributed in eastern México, from the southeast of the state of Tamaulipas southward to the Isthmus of Tehuantepec in Oaxaca; from there, 1 branch to the west of the state of Chiapas and the other to the Yucatán Peninsula, including the state of Campeche (Vargas-Contreras et al. 2014, 2016; Pardiñas et al. 2017), but it had not been found in the municipality of Palizada (study area), so the present record expands the distribution of the genus *Sigmodon* in the state. The nearest record is in the municipality of El Carmen (Sánchez-Cordero et al. 2020), 62.5 km southeast of the study area (calculated in a straight line between the 2 geographic points).

In the Management Program of the Laguna de Términos Natural Wildlife Protection Area (INE 1997), 27 families with 134 species of mammals are mentioned as part of the terrestrial fauna; however, rodents are mentioned without referring to any particular species. Annex 1 of the amendment to this Program (CONANP 2018) lists the mammals that live in APFFLT (page 145), mentioning 9 species of rodents: tepezcuintle or lowland Paca (*Agouti paca* = *Cuniculus paca*), Mexican tree porcupine or Mexican hairy dwarf porcupine (*Coendou mexicanus* = *Sphiggurus mexicanus*), hispid pocket gopher (*Orthogeomys hispidus*), fulvous pygmy rice rat (*Oryzomys fluvescens* = *Oligoryzomys fulvescens*), Hatt's vesper rat (*Otonyctomys hattii*), Yucatán deer mouse (*Peromyscus yucatanicus*), slender harvest mouse (*Reithrodontomys gracilis*), Deppe's squirrel (*Sciurus deppei*), and Yucatán gray squirrel (*Sciurus yucatanensis*), but *Sigmodon* is not mentioned as present in the protected area.



Figure 2. Skulls and mandibles (CNMA Catalog Numbers 50313 and 50314) of the cotton rat, *Sigmodon toltecus*.

Sigmodon toltecus is found in continental environments, with a distribution restricted to tropical coastal zones, and is endemic to Mesoamerica (Pardiñas et al. 2017). This species is not listed in any conservation category by México's Secretariat of Environment and Natural Resources (NOM-059-SEMARNAT-2010) nor by the International Union for the Conservation of Nature (IUCN 2022).

There are few records of the presence of mammals in the diet of the Neotropical otter in México; of these, only 2 studies have identified these preys at the species level: Gallo-Reynoso (1997) in the Sierra Madre del Sur, Chiapas, recorded the consumption of field rat (*Neotoma* spp.), squirrel (*Spermophilus mexicanus*), and raccoon (*Procyon lotor*); in the Bavispe-Yaqui River, Sonora, Rangel-Aguilar and Gallo-Reynoso (2013) reported the consumption of field mouse (*Peromyscus eremicus*) and other unidentified rodents.

In the state of Campeche, México, this is the third record of rodent predation by the Neotropical otter in river-lagoon systems but the first record of predation on the cotton rat, *S. toltecus*. This incidental record broadens the trophic spectrum of the Neotropical otter, as it shows the diversity of its prey (Gallo-Reynoso et al. 1989; Macías-Sánchez and Aranda 1999). Additionally, it expands the distribution of this prey species; although the prey could have been consumed in a place other than the collection site, it is assumed that the hunting site is nearby (approximately 7 km, according to Gallo-Reynoso et al. 2008). Thus, the present work highlights the importance of *L. l. annectens* in the study area, given the variability of its food, documenting the consumption of species not previously recorded in the

area. Therefore, efforts to collect and identify the prey species of the Neotropical otter should continue.

Acknowledgements

The work is part of the activities of 2 scientific research projects registered with the *Dirección General de Investigación y Posgrado* (General Directorate of Research and Postgraduate Studies; DGlyP, in Spanish) of UNACAR, with code numbers FCN/2016/07 and FCN/1ERP2022/02. Fieldwork was carried out under the scientific collection licenses for wildlife teaching purposes, DGVS-SEMARNAT: SGPA/DGVS/05057/17, SGPA/DGVS/09274/17, SGPA/DGCV/007600/18, and SGPA/DGVS/10652/19. We thank P. de la Rosa Barbosa for photographing the skulls and mandibles. Comments from 2 anonymous reviewers contributed to improving this note. M. E. Sánchez-Salazar translated the manuscript into English.

Literature cited

- ÁLVAREZ-CASTAÑEDA, S. T., T. ÁLVAREZ, AND N. GONZÁLEZ-RUIZ. 2015. Guía para la identificación de los mamíferos de México en campo y laboratorio / Keys for identifying Mexican mammals in the field and the laboratory. Centro de Investigaciones Biológicas del Noroeste S.C., Escuela Nacional de Ciencias Biológicas, Universidad Metropolitana Iztapalapa. México City, México.
- COLL DE HURTADO, A. 1975. El suroeste de Campeche y sus recursos naturales. Instituto de Geografía, UNAM, Serie Científica. México City, México.
- COMISIÓN NACIONAL DE ÁREAS NATURALES PROTEGIDAS (CONANP). 2018. Modificación del Programa de Manejo del Área de Protección de Flora y Fauna laguna de Términos. Documento para consulta pública 65 LGEEPA y 79 RANP. México City, México.
- CONVENTION ON INTERNATIONAL TRADE IN ENDANGERED SPECIES OF WILD FAUNA AND FLORA (CITES). 2023. Checklist of CITES Species. <http://www.cites.org>. Accessed on September 30, 2023.
- GALLO REYNOSO, J. P. 1989. Distribución y estado actual de la nutria o perro de agua (*Lontra longicaudis annectens* Major, 1897) en la Sierra Madre del Sur, México. Master's Thesis. Facultad de Ciencias, Universidad Nacional Autónoma de México. México City, México. Available at: jpgallo@ciad.mx.
- GALLO-REYNOSO, J. P. 1997. Situación y distribución de las nutrias en México, con énfasis en *Lontra longicaudis annectens* Major, 1897. *Revista Mexicana de Mastozoología* 2:10-32.
- GALLO-REYNOSO, J. P., N. N. RAMOS-ROSAS, AND O. RANGEL-AGUILAR. 2008. Depredación de aves acuáticas por la nutria neotropical (*Lontra longicaudis annectens*), en el río Yaqui, Sonora, México. *Revista Mexicana de Biodiversidad* 79:275-279.
- INSTITUTO NACIONAL DE ECOLOGÍA (INE). 1997. Programa de Manejo del Área de Protección de Flora y Fauna Laguna y Términos, primera edición. Talleres de Retículas Gráficas, S. A. de C. V. México City, México.
- INTERNATIONAL UNION FOR CONSERVATION OF NATURE (IUCN). 2022. The IUCN List of threatened Species: Red List. <https://www.iucnredlist.org>. Accessed on September 30, 2023.
- JARDEL, E. J., A. SALDAÑA, AND M. T. BARREIRO. 1987. Contribución al conocimiento de la ecología de los manglares de la Laguna de Términos, Campeche, México. *Ciencias Marinas* 13:1-22.
- LESSMANN, J., J. ARRIVALLAGA, AND M. AGUILERA. 2011. Caracterización molecular de poblaciones venezolanas de *Sigmodon hirsutus* (Rodentia: Cricetidae). *Revista de Biología Tropical* 59:795-807.
- MACÍAS-SÁNCHEZ, S., AND M. ARANDA. 1999. Análisis de la alimentación de la nutria (*Lontra longicaudis*) (Mammalia: Carnivora) en un sector del río los pescados, Veracruz, México. *Acta Zoológica Mexicana (nueva serie)* 76:49-57.
- MAMMAL DIVERSITY DATABASE (MDD). 2023. Mammal Diversity Database of the American Society of Mammalogists (ASM) v1.11. <https://mammaldiversity.org>. Accessed on September 30, 2023.
- MARIANO-MENDOZA, V. G., ET AL. 2022. Ecological aspects of the Neotropical otter, *Lontra longicaudis annectens* (Major, 1897), in La Lagartera Lagoon, Campeche, Mexico. *Hidrobiológica* 32:93-103.
- PARDIÑAS, U. F., ET AL. 2017. Family Cricetidae (True hamsters, voles, lemmings and new world rats and mice). Pp. 156-535 in *Handbook of the Mammals of the World* (Wilson, D. E., R. A. Mittermeier, and T. E. Jr. Lacher, eds.). Vol 7. Rodents II. Lynx Edicions. Barcelona, España.
- PEPPERS, L. L., D. S. CARROLL, AND R. D. BRADLEY. 2002. Molecular systematics of the genus *Sigmodon* (Rodentia: Muridae): evidence from the mitochondrial cytochrome-b gene. *Journal of Mammalogy* 83:396-407.
- RANGEL-AGUILAR, O., AND J. P. GALLO-REYNOSO. 2013. Hábitos alimentarios de la nutria neotropical (*Lontra longicaudis annectens*) en el Río Bavispe-Yaqui, Sonora, México. *Therya* 4:297-310.
- RHEINGANTZ, M., ET AL. 2017. Biogeographic patterns in the feeding habits of the opportunist and semiaquatic Neotropical otter. *Hydrobiologia* 792:1-15.
- SÁNCHEZ-CORDERO, V., A. RODRÍGUEZ-MORENO, AND G. GUTIÉRREZ-GRANADOS. 2020. Modelado de la distribución potencial de especies de mamíferos reservorios y vectores de tres zoonosis emergentes en México. Universidad Nacional Autónoma de México. Instituto de Biología. Informe final SNIB-CONABIO. SNIB-CONABIO, proyecto No. JM040. Ciudad de México, México.
- SECRETARÍA DE MEDIO AMBIENTE Y RECURSOS NATURALES (SEMARNAT). 2010. NOM-059-SEMARNAT-2010. Protección ambiental-Especies nativas de México de flora y fauna silvestre-Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio-Lista de especies en riesgo. Accessed on September 30, 2023.
- VARGAS-CONTRERAS, J. A., ET AL. 2014. Los Mamíferos del estado de Campeche. *Revista Mexicana de Mastozoología (Nueva Época)* 4:60-74.
- VARGAS-CONTRERAS, J. A., ET AL. 2016. Conservación de los mamíferos de Campeche. Pp. 129-154 in *Riqueza y Conservación de los Mamíferos en México a Nivel Estatal* (Briones-Salas, M., et al., eds.). Instituto de Biología, Universidad Nacional Autónoma de México, Asociación Mexicana de Mastozoología A. C. y Universidad de Guanajuato. México City, México.
- VÁZQUEZ-MALDONADO, L. E., AND A. DELGADO-ESTRELLA. 2022. Diet of *Lontra longicaudis* in La Sangría Lagoon, México. *Therya Notes* 3:125-132.

Associated editor: José F. Moreira Ramírez.

Submitted: December 5, 2023; Reviewed: January 17, 2024.

Accepted: February 19, 2024; Published on line: February 29, 2024.