

## Occurrence of *Notodiaptomus maracaibensis* Kiefer, 1954 (Copepoda: Calanoida, Diaptomidae) from an ephemeral pond in northern Colombia

## Presencia de *Notodiaptomus maracaibensis* Kiefer, 1954 (Crustacea: Copepoda: Calanoida, Diaptomidae) en una charca temporal al norte de Colombia

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Recibido: xx

Aceptado: xx

Publicación en línea: xx

### Abstract

#### Key words:

copepods; diaptomids;  
freshwater zooplankton;  
La Guajira; taxonomy

The Neotropical planktonic freshwater copepod *Notodiaptomus maracaibensis* Kiefer, 1954 was found in a small temporal pond in northern La Guajira. Hitherto, it has been reported from Venezuela and Colombia, mainly in the Caribbean region. This is the first documented, illustrated record confirming its presence in Colombia and La Guajira department. Our specimens from La Guajira, have the combination of diagnostic features of *N. maracaibensis* as reported in both the original description and subsequent taxonomical accounts, including: 1) segment 15 of male right antennule lacking spinous process, 2) inner margin of male right P5 basipodite smooth, 3) male right P5 endopod short, 4) male right P5 exopod 2 almost 2.5 times as long as wide; 5) lateral spine of male P5 exopod2 inserted subdistally; 6) lateral wings of female pediger 5 asymmetrical, 7) inner margin of female lateral wings with a spinules row, 8) left lateral wing with both sensilla inserted closer to each other than on right wing; 9) female genital double-somite 1.5 times as long as wide, 10) both sensilla of genital double-somite arranged perpendicularly to body axis. In Colombia, *Notodiaptomus maracaibensis* superficially resembles *N. henseni*, also reported from Colombia; these two species can easily be confused; we provide key morphological details to distinguish these species in Colombia. A key to the species of *Notodiaptomus* found in Colombia is also provided.

#### Palabras claves:

copépodos; diatómidos;  
zooplancton de agua dulce;  
La Guajira; taxonomía

### Resumen

El copépodo planctónico de agua dulce *Notodiaptomus maracaibensis* Kiefer, 1954 fue encontrado en un pequeño estanque temporal al norte de La Guajira, Colombia. Hasta ahora, se ha registrado solamente en Venezuela y Colombia. Este es el primer registro ilustrado y documentado que confirma su presencia en Colombia y el departamento de La Guajira. Nuestros especímenes de La Guajira tienen la combinación de caracteres diagnósticos propios de *N. maracaibensis*, tal como se consigna tanto en su descripción original como en los trabajos taxonómicos posteriores, incluyendo: 1) segmento 15 de la anténula derecha del macho sin proceso espinoso, 2) margen interno del basipodito de la P5 derecha del macho liso, 3) endopodito de la P5 derecha del macho corto, 4) segundo segmento exopodal de la P5 derecha del macho casi 2.5 veces más largo que ancho; 5) espina lateral del segundo segmento exopodal de la P5 derecha del macho insertada subdistalmente; 6) procesos laterales del pedígero 5 de la hembra ligeramente asimétricos; 7) borde posterior de los procesos laterales del pedígero 5 de la hembra con una hilera de espinulas; 8) proceso lateral izquierdo del pedígero 5 de la hembra con ambas sensilas insertadas más cerca una de la otra que en el lado derecho; 9) doble somita genital 1.5 veces más largo que ancho, 10) ambas sensilas del somita genital dispuestas perpendicularmente al eje del cuerpo. *Notodiaptomus maracaibensis* se parece superficialmente a *N. henseni*, también presente en Colombia y ambas podrían confundirse fácilmente; por ello presentamos algunos detalles que permiten diferenciar ambas especies. También se proporciona una clave para las especies de *Notodiaptomus* que se encuentran en Colombia.



## Introducción

The genus *Notodiaptomus* was proposed by Kiefer (1936) to include eleven species originally placed in *Diaptomus* Westwood, 1836 sensu lato (Santos-Silva *et al.*, 1999). This genus has the widest distribution of freshwater calanoids in the Neotropical region (Santos-Silva *et al.*, 1999, Santos-Silva *et al.*, 2013). Members of this genus can be found both in lentic and lotic aquatic ecosystems (Previattelli *et al.*, 2013) and they are restricted to the Neotropical region (Walter and Boxshall, 2021). The diversity of this genus is the greatest among the calanoid copepod family Diaptomidae; it currently comprises 36 valid species (Suárez-Morales *et al.*, 2020). Of these, *Notodiaptomus coniferoides* (Wright, 1927), *N. echinatus* (Lowndes, 1934), *N. henseni* (Dahl, 1894), *N. maracaibensis* Kiefer, 1954, *N. simillimus* Cicchino, Santos Silva & Robertson, 2001 have been known to occur in Colombia (Kiefer, 1956; Cicchino *et al.*, 1989; Atencio *et al.*, 2005; Alvarez, 2010, Jaramillo-Londoño and Aguirre-Ramirez, 2012; Dussart, 1984; Rivera-Rondón *et al.*, 2010; Villabona-González *et al.*, 2011). Furthermore, Gaviria and Aranguren (2019) recorded 7 species of *Notodiaptomus* for Colombia and added *N. linus* (Brandorff, 1973) and *N. dilatatus* Dussart, 1984, but the latter two species are currently considered members of the genus *Diaptomus* (Suárez-Morales *et al.*, 2020). In this manuscript, we followed the criterion of the latter authors.

*Notodiaptomus maracabiensis* was originally described from Lago de Maracaibo, Venezuela by Kiefer (1954). Hitherto, in Colombia, this species has been recorded in both the Caribbean and Pacific regions, having a wide distribution in the former (Gaviria and Aranguren, 2019) The aim of this paper is to document the first finding of *N. maracabiensis* for La Guajira Department. Differing from previous regional and national records, our report includes a brief description of the specimens examined, illustrations of relevant taxonomic characters of this species, and a comparative analysis with respect to its closest congener in Colombia. A key for the identification of the species of *Notodiaptomus* found in Colombia is also provided.

## Materials and Methods

Biological samples were taken from a small temporary pond at Ebanal farm, northern sector of La Guajira-Colombia, (11°45'23.37" N; 72°25'10.97" W). Qualitative surveys were performed during October and November 2018. Environmental parameters were measured with a WTW 3111 conductivity meter gear. Water samples were collected using a bucket of 25

L, sieved through a standard zooplankton net (55 µm mesh) until to obtain concentrates of 500 ml that and fixed in 96 % ethanol. In the laboratory, samples were concentrated to 50 ml and stained with Bengal rose. The copepods were sort and count using a Bogorov chamber and with the aid of a stereomicroscope; they were taxonomically examined in toto under a compound optical microscope in a drop of glycerol-formaldehyde mixture. Specimens were measured in ventral position, from the anterior end of the cephalothorax to the posterior margin of the caudal ramus and then they were dissected to examine the taxonomically relevant appendages, which were mounted in semi-permanent slides. The appendages with taxonomic relevance were drawn using a drawing tube and also photographed with a Kodak Easy Share C140 digital camera adapted to a compound microscope at 1000x magnification. The identification of this species was based on the original description and illustrations by Kiefer (1954, 1956); we also followed the taxonomic key by Suárez-Morales *et al.* (2020). Our morphologic remarks and complementary description followed Huys and Boxshall's (1991) terminology. The following abbreviations are used in the text: P1-P6 = first to sixth legs; EXP = exopod; ENP = endopod.

Voucher specimens of *N. maracaibensis* were deposited at the Centro de Colecciones Biológicas held at the Universidad del Magdalena, Colombia (CBUMAG: MEI: 0825 and CBUMAG: MEI: 0826) where they are available for consultation and/ or further examination.

## Results

Order Calanoida Sars G. O., 1903  
Family Diaptomidae Baird, 1850  
Subfamily Diaptominae Kiefer, 1932  
Genus *Notodiaptomus* Kiefer, 1936  
*Notodiaptomus maracaibensis* Kiefer, 1954

Material examined: 7 adult females and 5 adult males from an ephemeral pond located in La Guajira, Colombia (11°45'23.37" N; 72°25'10.97" W), plankton net, October - November 2018, coll. JMF-R.

## Morphology

Female. Body length of the La Guajira-Colombia female specimens = 1064 –1092 µm (n = 7, average length = 1075 µm) (figure 1A). Antennules Symmetrical, 25- segmented, reaching beyond caudal rami (figure 1A), pediger 5 wings asymmetric, with one pair of sensillae on each side; left side with both sensilla inserted closer to each other than on right side, inner sensilla

thinner (figure 2A); posterior margin ornamented with small spinules (figure 1C, D). Urosome 3-segmented (figures 1B, 2B, C). Genital double-somite symmetrical, weakly produced ventrally (figures 1A, 2C), about 1.4 times as long as wide

(figures 1A, 2C), longer than the other urosomites lengths combined (figure 1B). Somite with laterally directed sensillum on each side (figure 2A, C). Caudal rami symmetrical, about 1.6 times as long as wide (figure 2C).

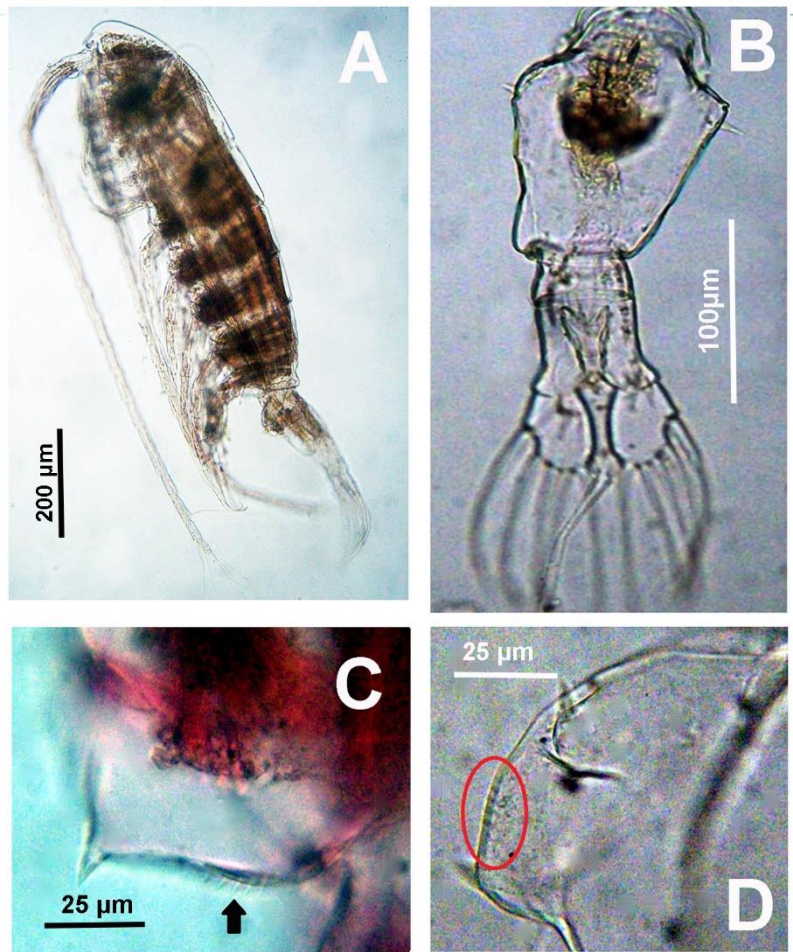


Figure 1. *Notodiaptomus maracaibensis* Kiefer, 1954 from La Guajira, Colombia. Adult female. A. habitus, lateral view. B. urosome, ventral view. C. left wing of pediger 5 showing spinule ornamentation. D. same, right wing.

P1–P4 with 3-segmented exopods and endopods, except for 2-segmented P1ENPs (figure 3A–D). P5 symmetrical (figure 2D), coxa with sensilla on outer margin, basis subtriangular with short outer basipodal seta (figures 2D, 5B). Exopod 3-segmented. EXP1 robust, about 2.4 times as long as wide, with small subdistal sensilla (figures 2E, 3C). EXP2 represented by stout terminal claw with small denticles along lateral margins, with small outer spine on proximal position (figures 2E, 5C). EXP3 small, subquadrate, armed with two stout terminal setal elements, outer shorter than inner (figure 2E). Endopod 1-

segmented reaching about mid length of EXP1 (figures 2D, 5B) with a brush of short spinules apically (figure 2F).

Male: Body length of the La Guajira-Colombia male specimens = 938 – 980 µm (n = 5, average length = 969 µm). Left antennule as in female. Right antennule geniculate, with segments 14–19 modified, expanded, bearing spinous processes on segments 9, 11, 12, 14, 16, and 17 (figures 4B). Antepenultimate segment with short, acute process on distal position, not reaching proximal margin of succeeding segment (figure 4A).

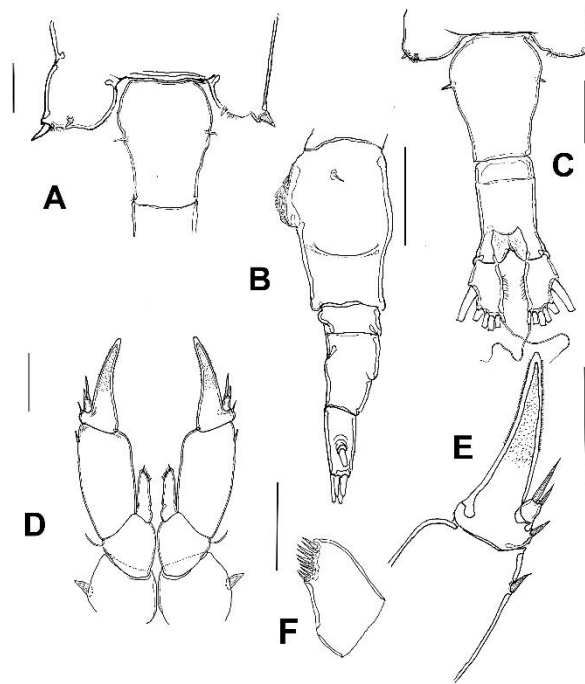


Figure 2. *Notodiaptomus maracaibensis* Kiefer, 1954 from La Guajira, Colombia. Adult female. A. pediger 5 and genital double-somite, dorsal view. B. urosome, lateral view. C. same, dorsal view. D. fifth leg. E. right fifth leg, distal segment. F. apical end of endopodite. Scale bars: A-C= 60  $\mu$ m, D, E= 25  $\mu$ m, F= 10  $\mu$ m.

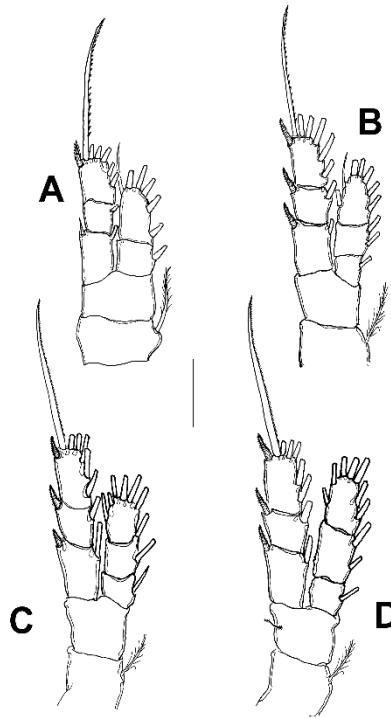


Figure 3. *Notodiaptomus maracaibensis* Kiefer, 1954 from La Guajira, Colombia. Adult female. A. leg 1. B. leg 2. C. leg 3. D. Leg 4. Scale bars: A-D= 50  $\mu$ m.

P1-P4 as in female, P5 biramous, strongly asymmetrical (figure 4C). Right P5. Coxa with large conical process (figure 4C). Exopod 2-segmented; first segment with short acute process on outer distal margin and small distal sclerotized process projecting over second exopodal segment (figure 4C); second segment with a lateral spine inserted subdistally; terminal claw strong, curved (figure 4C). Endopod short, 1-segmented, with row of spinules on inner margin (figure 4C).

subrectangular, with short outer basipodal seta. Exopod 2-segmented, EXP1 robust, about half as long as basipodite, with curved outer margin; inner margin with small thumb-like process ornamented with setules. EXP2 with inner margin expanded into subtriangular lamella ornamented with inner row of spinules; outer corner with small distal seta. Distal half of EXP2 tapering distally into pair of chitinized digitiform processes (figure 4D). Endopod wide, conical, 1-segmented, with row of spinules on inner margin, ENP almost reaching distal end of EXP2 (figure 4C, D).

Left P5. Leg barely reaching right leg EXP1. Basipodite robust,

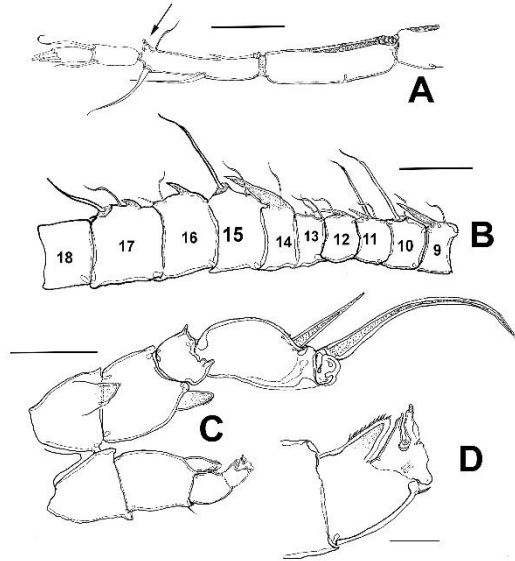


Figure 4. *Notodiaptomus maracaibensis* Kiefer, 1954 from La Guajira, Colombia. Adult male. A. antepenultimate segment of male right antennule showing acute process (arrow). B. right antennule segments 9-18. C. fifth leg. D. detail of terminal exopodal segment of left fifth leg. Scale bars: B= 50  $\mu$ m, C= 60  $\mu$ m, D= 10  $\mu$ m.

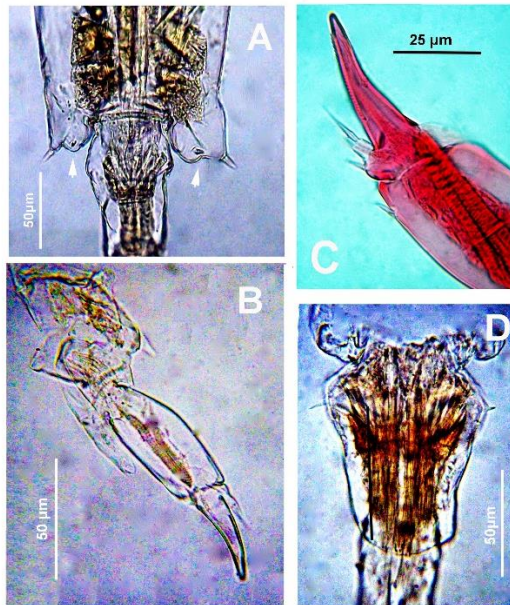


Figure 5. *Notodiaptomus maracaibensis* Kiefer, 1954 from La Guajira, Colombia. Adult female. A. fifth pediger lateral wings and genital double-somite, dorsal view. B. fifth leg. C. detail of fifth leg. D. genital double-somite, dorsal view.

## Discussion

The morphology of the seven adult female and five male specimens from La Guajira, Colombia agrees with previous descriptions and illustrations of the species (Kiefer, 1956; Suárez-Morales *et al.*, 2020).

*Notodiptomus maracaibensis* can be separated from its closest congeners by a unique combination of characters including: 1) segments 13 and 15 of male right antennule lacking spinous process (figure 4B), 2) inner margin of male right P5 basipodite smooth, 3) male right P5 endopod short, 1-segmented, 4) male right P5 EXP2 almost 2.5 times as long as wide, 5) lateral spine (aculeus) of male right P5 EXP2 inserted subdistally; 6) female lateral wings of pediger 5 weakly asymmetrical, 7) inner margin of female lateral wings with row of spinules, 8) left lateral wing with both sensilla inserted closer to each other than on right wing, 9) genital double-somite 1.5 times as long as wide, 10) both sensilla on genital double-somite arranged perpendicularly to body axis. These distinctive traits are present in our Colombian specimens. In his original description of this species, Kiefer (1956) depicted the antepenultimate segment of the male right antennule as having a weak distal expansion (Kiefer, 1956, fig. 16), whereas a strong, acute process is present in the specimens examined (arrow in figure 4A).

The genus *Notodiptomus* was divided by Wright (1935) into two distinct groups: the nordestinus-complex containing 13 species and the genus *Notodiptomus* by Kiefer, comprising the remaining species (Santos-Silva *et al.*, 2013). *Notodiptomus maracaibensis* is included in the latter group.

In Colombia, *N. maracaibensis* superficially resembles *N. henseni* and they could be easily confused. These two species can be distinguished by several subtle characters including: 1) *N. maracaibensis* has small denticles on the inner margin of the female lateral wings (Kiefer, 1954, Abb. 5; Kiefer 1956, Abb. 10; Suárez-Morales *et al.*, 2020, figure 21.8K, GS, present data, figures 1C-D, 2A, C); this ornamentation is absent in *N. henseni* (Santos-Silva *et al.*, 2013, Suárez-Morales *et al.*, 2020); 2) distal portion of last pediger with spinules in *N. henseni* (Santos-Silva *et al.*, 2013; Suárez-Morales *et al.*, 2020), vs. smooth surface in *N. maracaibensis* (Kiefer, 1954, Abb. 5; Kiefer, 1956, Abb. 10; Suárez-Morales *et al.*, 2020, present data, figures 1C-D, 2C, 3) segment 13 of male antennule without spinous process in *N. maracaibensis* (Kiefer, 1954, Abb.7; Kiefer, 1956, Abb. 12; Suárez-Morales *et al.*, 2020; present data, figure 4B) vs. such segment with a spine in *N. henseni* (Santos-Silva *et al.*, 2013, Suárez-Morales *et al.*, 2020).

## Distribution

So far, *Notodiptomus maracaibensis* is exclusively distributed in the Neotropical region and has been recorded from two countries: Venezuela (Kiefer, 1954) and Colombia (Gaviria and Aranguren, 2019). In the latter country it has been recorded from different areas (Atencio *et al.*, 2005; Álvarez, 2010; Gaviria and Aranguren, 2019; Villabona-González *et al.*, 2011), but illustrations and morphologic comparisons of the Colombian populations have not been yet provided for this species. This is the first documented, illustrated record confirming its presence in Colombia and La Guajira department.

Only three Neotropical diaptomid species were included as Threatened in the 1996 Red List (Reid *et al.*, 2002). Currently, *Notodiptomus maracaibensis* is considered to be threatened (Daga *et al.*, 2020) and has been included at the IUCN Red species (Baillie and Goombridge, 1996). Our finding from ephemeral ponds in northern Colombia suggests that its conservation status should be reviewed.

## Key to the species of *Notodiptomus* recorded in Colombia

- 1A. Lateral spine of right Exp2P5 less than 1/5 (20 %) length of terminal claw.....2A
- 2A. Left side of genital double-somite with additional semicircular inflated area, without dorsal hump on female fourth pediger, modified seta on segment 13 of male right antennule small, reaching midlength of segment 14.....*Notodiptomus simillimus* Cicchino, Santos-Silva & Robertson, 2001.
- 2B. Left side of genital double somite lacking additional semicircular inflated area, with dorsal hump on female fourth pediger, modified seta on segment 13 of right male antennule long, reaching distal end of segment 14.....*Notodiptomus coniferoides* (Wright, 1927)
- 1B. Lateral spine of right Exp2P5 more than 1/5 (20 %) length of terminal claw.....3A
- 3A. Lateral spine of right EXP2 P5 inserted distally, last segment of female urosome lacking a strong hump.....4A
- 3B. Lateral spine of right EXP P5 inserted medially, last segment of female urosome with a strong hump.....*Notodiptomus echinatus* Lowndes 1934

4A. distal portion of last pediger without spinules, with small denticles on the end edge of lateral wings females, segment 13 of male antennule without spine.....  
*Notodiptomus maracaibensis* Kiefer 1954

4B. distal portion of last pediger with spinules, without small denticles on the end edge of lateral wings females, segment 13 of male antennule with spine.....  
*Notodiptomus henseni* (Dahl, 1894)

## Acknowledgements

We are deeply indebted to Jorge David Olivero Villanueva for help in the field. This study was financially supported by FONCIENCIAS of Magdalena University.

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**Cite:** Fuentes-Reinés, J.M., Suárez-Morales, E. and Eslava, P. 2021. Occurrence of *Notodiaptomus maracaibensis* Kiefer, 1954 (Copepoda: Calanoida, Diaptomidae) from an ephemeral pond in northern Colombia. *Intropica* 16(2): xx. Doi: xxx.