Tooth impaction and inclusion: challenges and advances in diagnosis and treatment

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Abstract

This report aims to provide helpful information for the immediate diagnosis and management of tooth inclusion, focusing on how to diagnose and treat it. Dental inclusion affects both primary and permanent teeth and results from genetic, environmental, and local factors. Maxillary canines, third molars, and premolars are the most commonly impacted teeth. Causes include genetic factors, systemic diseases, and local anatomical issues like crowding or supernumerary teeth. Inclusion may occur due to eruption failure or mechanical obstruction. Accurate and early diagnosis with clinical exams, radiographs, and cone-beam computed tomography (CBCT) is crucial for effective treatment planning. Treatment options range from non-surgical orthodontic methods, such as guided traction of impacted canines, to surgical procedures like removing obstructions or exposing impacted teeth. Early intervention is better because it uses the fact that root development is incomplete and bone is more adaptable in younger patients. Collaboration among specialists and technological advances has greatly improved the management of tooth inclusion. More research is needed to understand the genetic factors and develop less invasive treatment options.

Keywords: Dental impaction, Early diagnosis, Minimally invasive treatment, Multidisciplinary approach

Introduction

Tooth inclusion, a developmental anomaly where a tooth fails to erupt into the oral cavity, is an essential topic in dental and orthodontic research. This condition affects both primary and permanent teeth, leading to various clinical issues. Factors contributing to tooth inclusion can be categorized as genetic, environmental, or local, and it is often linked with conditions such as impaction, delayed eruption, and developmental malocclusion. Understanding the pathogenesis of tooth inclusion, diagnosing it accurately, and applying appropriate treatment strategies are crucial for effective dental care and early interventionb(1–2). Tooth inclusion is a cosmetic concern and can significantly impact oral health and function. Studies have shown tooth impaction can hinder proper chewing, alter bite alignment, and cause discomfort or pain. Therefore, understanding the underlying causes, diagnostic tools, and treatment options is essential for improving patient outcomes. This manuscript examines the various aspects of tooth inclusion, emphasizing advances in diagnosis and treatment.

Etiology of Tooth Inclusion

The etiology of tooth inclusion is multifactorial, and genetic, environmental, and local factors influence it. (Table 1) Genetic predisposition plays a significant role in

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Table 1. Summary of the etiological factors for tooth inclusion

Etiological Category	Examples/Mechanism	Clinical Relevance
Genetic Factors	Hereditary syndromes; Familial patterns of tooth inclusion; Genetic influence on eruption pathways	Helps identify at-risk patients based on family history and supports preventive monitoring strategies
Environmental or Systemic Factors	Trauma to primary teeth affecting permanent bud (e.g., dilacerations); Developmental disorders (e.g., cleft lip/palate); Endocrine abnormalities; Bone diseases	Emphasizes the importance of thorough medical and trauma history in diagnostic evaluation.
Local Factors	Crowding and lack of space; Supernumerary teeth; Odontomas; Ectopic positioning of tooth bud; Ankylosed or non-vital primary teeth; Premature loss or prolonged retention of deciduous teeth; Mucosal or bony barriers	Often requires radiographic investigation (e.g., CBCT) to identify mechanical obstructions or eruption path deviations.

tooth inclusion, with studies revealing that individuals with hereditary conditions show a higher prevalence of impacted or included teeth. Research has consistently demonstrated that dental anomalies, such as impacted teeth, are more prevalent in families with a history of similar issues, indicating a genetic influence. Clementini et al.b(1) explored how genetic factors could predispose specific individuals to tooth impaction, suggesting that the genetic underpinnings of tooth eruption could be involved in developmental anomalies. Environmental and systemic conditions also contribute to tooth inclusion. Trauma to the developing tooth, infections, or developmental disorders such as cleft lip and palate, can interfere with the eruption process, leading to impaction (5). Similarly, local factors—such as overcrowding, insufficient space for eruption, or the presence of supernumerary teeth or odontogenic cysts—are significant contributors to tooth inclusionb(6). Studies, including those by Lione et al. (2), have emphasized how local factors can obstruct normal eruption pathways, causing impaction. In particular, the ectopic eruption and impaction of maxillary permanent canines is a frequently encountered clinical problem: the frequency ranges from 1.7% in the general population to 4.3% in the subjects referred to clinical practice (32). The most common causes for canine impactions are usually localized. They are the result of one or a combination of the following factors: lack of space, tooth size-arch length discrepancies, constricted maxillary arch, prolonged retention or early loss of the deciduous canines, absence of maxillary lateral incisors and variation in the root size of the tooth (7). Other possible causes of uneruption are: ectopic tooth bud position (8), ankylosis of primary teeth (9), early extraction or early loss of primary teeth, mucosal barriers in the path of eruption, endocrine abnormalities and/or bone diseases (10).

Prevalence of tooth Inclusion

Tooth inclusion most often occurs in the permanent dentition, particularly with maxillary canines, third molars, and premolars (11). The prevalence of impacted teeth differs among populations, with studies indicating that impacted maxillary canines occur in 1-3% of the general population (11). Impacted third molars are even more common, with reports showing an incidence of up to 25% (9). Other teeth, such as maxillary lateral incisors, mandibular premolars, and mandibular canines, are less frequently impacted but can still pose clinical challenges. Lione et al. (2) discussed how the prevalence of impaction varies across different age groups and populations, highlighting the importance of targeted intervention in these cases. The prevalence of tooth inclusions is detailed in Table 2.

Pathogenesis of Tooth Inclusion

Tooth inclusion can be divided into two main categories based on its underlying mechanisms: failure of eruption and mechanical obstruction. Eruption failure happens when there is an intrinsic defect in the eruption process, which may be connected to abnormalities in the development of the tooth or its surrounding tissues (12,13).

Supernumerary teeth and odontomas are the leading causes, making up 60% of cases, as they block the eruption path of permanent incisors (14). Eruption problems can also result from anomalies in tooth formation or dilacerations. Dilacerations usually occur after trauma to a primary tooth, which can affect the development of the underlying permanent tooth germ because of their close anatomical relationship. The severity of damage to the permanent tooth depends on the stage of tooth development at the time of trauma, as well as the type and direction of the traumatic event (15).

Mechanical obstruction occurs when external factors, such as local anatomical barriers (cysts, tumors, or supernumerary teeth), prevent the tooth from erupting. This obstruction often causes the tooth to stay in an abnormal position within the jaw. According to Lione et al. (2), the presence of supernumerary teeth, which can block the eruption path, is one of the most common mechanical causes of tooth impaction.

Opinions about the impact of third molar impaction on the crowding of lower front teeth remain debated. A

Table 2. Prevalence of tooth impaction

Tooth Type	Estimated Prevalence	Clinical Notes
Maxillary Canines	1-3%	Most frequently impacted tooth after third molars; often requires interceptive treatment
Maxillary incisors	0,2-1%	Impaction often associated with presence of supernumerary teeth or local obstruction
Maxillary Premolars	0,1-0,3%	Less frequent but still clinically relevant; varies by population
Mandibular canines	0,07-1%	Less common than maxillary counterparts; diagnosis may be delayed
Mandibular incisors	Rare	Impaction often associated with presence of supernumerary teeth or local obstruction
Mandibular Premolars	0,2-0,3%	Uncommon, and it may be undiagnosed
Third Molars	>25%	Most commonly impacted tooth overall; extraction frequently considered

recent systematic review concludes that clear findings cannot be established on whether third molars cause anterior tooth crowding. Most studies showed a high risk of bias, and their results were inconsistent. However, most research does not support a cause-and-effect link; therefore, removing third molars to prevent front tooth crowding or relapse after orthodontic treatment is unjustified. Another recent review by (11–12) authors suggests that impacted lower third molars might contribute to mandibular crowding and lower arch constriction. More high-quality, prospective research is needed to understand better the impact of third molars on lower front tooth crowding.

Diagnostic Approaches

The diagnosis of tooth inclusion usually starts with a comprehensive clinical exam, followed by radiographic assessment.

Clinical examination

When a tooth does not erupt at the expected time, the clinician must determine the underlying cause and create an appropriate treatment plan. An accurate diagnosis can be made through thorough clinical and radiographic evaluation. Reviewing the patient's medical history is essential to rule out local or systemic factors (12). It is important to ask both patients and their caregivers about any past dental trauma, including incidents during early childhood. The diagnosis of eruption delay is typically based on clinical and radiographic assessments. Additionally, physical examination and palpation of the alveolar ridge are recommended (15).

Radiographic evaluation

Radiographic evaluation confirms the presence of an impacted tooth and helps locate it. Periapical and panoramic radiographs are the most commonly used imaging methods for diagnosing impacted or included teeth.

On panoramic radiographs, Ericson and Kurol (16) introduced two methods to locate the maxillary canines (Figure 1): the alpha-angle (α), which indicates the

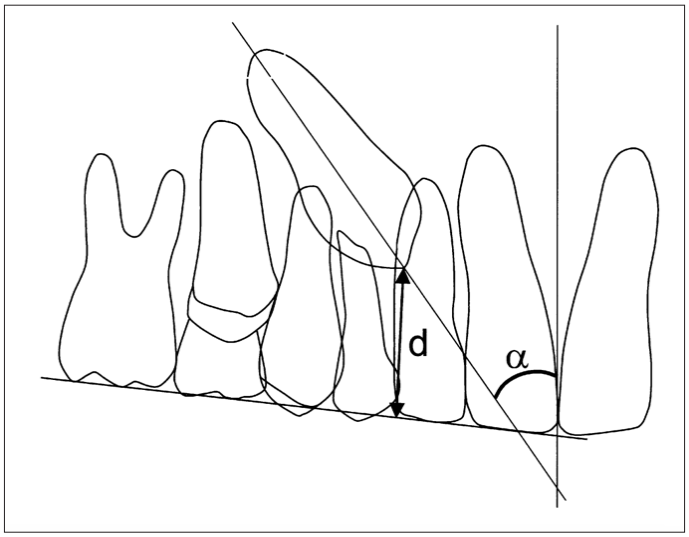

Figure 1. Measurement on panoramic radiographs: alpha angle (α) and d-distance (d).

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mesial tilt of the permanent canine's crown relative to the midline, and the d-distance (d), which measures the space between the canine's cusp tip and the occlusal plane.

This evaluation, using panoramic radiographs, aimed to describe the intraosseous location of the canines rather than predict displacement risk, as these indicators only become relevant prognostically after 10 to 11 years (17). Cone-beam computed tomography (CBCT) is often used to provide more detailed 3D imaging for suspected impaction cases (18).

CBCT has been shown to outperform other radiographic techniques in visualizing bone structures, as it accurately depicts the intraosseous position, angulation, and morphology of impacted teeth, along with their proximity to surrounding anatomical structures (19,20). Due to its high-resolution three-dimensional data, cone-beam computed tomography is the preferred method for locating unerupted teeth and detecting root resorption in neighboring teeth that may not be visible with traditional imaging. The detailed visualization and superior soft tissue contrast, free from blurring or superimposition of adjacent anatomy, often compensate for its drawbacks, such as higher radiation exposure, limited accessibility, and greater cost (21). Three-dimensional imaging allows for a comprehensive evaluation of the exact position and orientation of impacted teeth, their relationship to eruption barriers, internal and external anatomical features, the thickness of labial and palatal bone plates, signs of resorption in nearby teeth or bone pathology, and the presence or absence of a continuous radiolucent space between the root surface and bone—an indicator of possible ankylosis.

CBCT enables a more precise assessment of the impacted tooth's exact position and relationship with surrounding structures, offering valuable information for treatment planning. In some cases, additional diagnostic measures, such as cephalometric analysis or space analysis, may be needed to evaluate the available space for eruption (22).

Three-dimensional Cone Beam Computed Tomography (CBCT) reconstructions can significantly improve the visualization of impacted teeth and their anatomical relationships, aiding surgical planning and interdisciplinary communication in complex orthodontic cases. The volumetric rendering emphasizes the spatial relationship between impacted canines and nearby anatomical structures, enabling precise surgical planning and collaboration in a multidisciplinary orthodontic approach**.** These visual tools are handy in cases of maxillary canine impaction, as they provide accurate spatial orientation and facilitate collaborative decision-making among orthodontists, radiologists, and surgeons (Figure 2).

Management of Tooth Inclusion

The management of tooth inclusion depends on several factors, including the severity of impaction, the patient's age, and overall dental and facial development. Treatment methods are generally classified as either non-surgical or surgical. Ectopic or non-erupting canines can cause resorption of the roots of adjacent permanent teeth, formation of dentigerous cysts, and loss of arch length, leading to dental asymmetry (25). These potential complications highlight the importance of closely monitoring the development and eruption of these teeth during regular dental exams of the growing child. The diagnosis of canine impaction is based on clinical and radiographic examinations. When early signs of retained canines are identified, interceptive treatment should be administered to prevent impaction and its possible consequences (25). In the past, early treatment included several orthodontic and orthopedic approaches, such as rapid palatal expansion, cervical headgear, and extraction of deciduous canines and first molars, primarily aimed at restoring space for spontaneous eruption of maxillary canines and improving conditions for their proper eruption.

Non-Surgical Management

In some cases, orthodontic treatment can successfully reposition an impacted tooth into its correct position

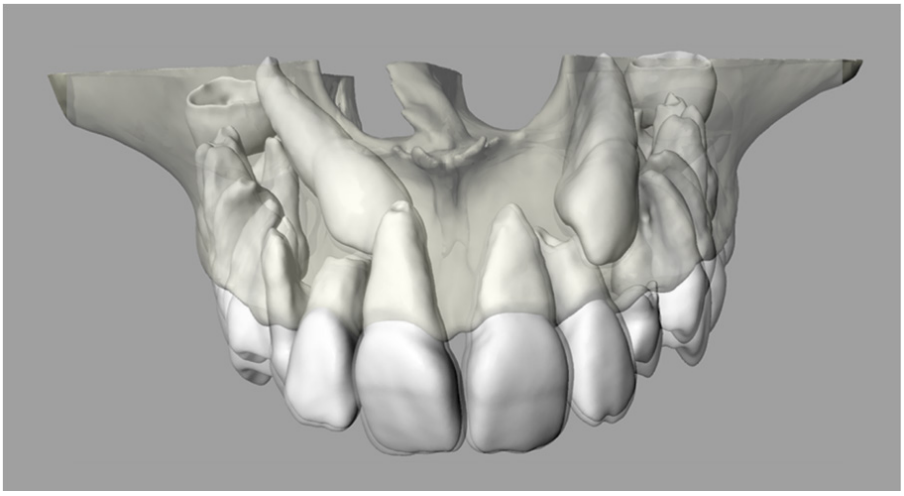

Figure 2. Three-dimensional reconstruction of a Cone Beam Computed Tomography (CBCT) scan showing bilateral maxillary canine impaction.

without surgery. This method is especially effective for impacted maxillary canines, where the tooth can be guided into place through orthodontic traction. The success rate of this approach is generally higher when treatment is started early, as younger patients often have more flexible bone structures that facilitate more effortless tooth movement. (28) Lione et al. (2) supported this idea, noting that early intervention is crucial for achieving the best outcomes in managing impacted teeth, especially in adolescents.

Surgical management

When orthodontic treatment alone is not enough, surgical intervention might be needed. Surgical procedures can include removing obstructive tissues, such as cysts or extra teeth, or surgically exposing the impacted tooth to help it erupt. An orthodontic bracket is often placed after surgical exposure to guide the tooth into the correct position (29). The timing of surgical intervention is critical for the procedure's success. Earlier interventions have better results because of less developed roots in younger patients.

Complications and prognosis

Tooth impaction can cause various complications, including pain, infection, displacement of nearby teeth, and periodontal problems such as gingival recession or bone loss. If not correctly managed, these issues can lead to long-term dental and functional difficulties (27). An impacted tooth can also hinder restorative procedures like crown or bridge placement due to altered eruption patterns. The outlook for impacted teeth mainly depends on factors like the impaction's location, the timing of treatment, and the overall health of the patient's oral structures (30).

Conclusions

Tooth inclusion remains a complex developmental anomaly that requires careful diagnosis and management to prevent long-term complications (31). Genetic, environmental, and local factors contribute to tooth impaction, and understanding these influences is vital for effective treatment (32). Diagnostic advances, such as 3D imaging, enable more precise assessments, and early surgical or non-surgical intervention enhances the likelihood of successful tooth eruption (33). Although significant progress has been made in managing tooth inclusion, it remains a challenging aspect of dental care that necessitates a multidisciplinary approach to achieve optimal outcomes (34). Future research into genetic factors, new orthodontic techniques, and minimally invasive surgical procedures offers hope for improving the management of tooth inclusion.

References

1. Clementini M, Ottria L, Pandolfi C, Agrestini C, Barlattani A. (2013). Four impacted fourth molars in a young patient: A case report. Oral Implantology (Rome), 5(4), 100-103. DOI: 10.1016/0030 4220(75)90254 6
2. Lione R., et al. (2020). Management of impacted teeth in the adolescent patient: A critical litera-ture review. Journal of Clinical Orthodontics, 54(2), 112-120.
3. Lione R, Brunelli V, Franchi L, Pavoni C, Quiroga Souki B, Cozza P (2017). Mandibular response after rapid maxillary expansion in class II growing patients: a pilot randomized controlled trial. Pro-gress in Orthodontics 18(11) 36.https://doi.org/10.1186/s40510-017-0189-6 DOI: 10.1186/s40510-017-0189-6 https://doi.org/10.1186/s40510-017-0189-6
4. Baccetti T, Franchi L. & McNamara JA. (2001). The influence of the deciduous canine relation-ship on the development of the maxillary permanent canine. Angle Orthodontist, 71(3), 201-209
5. Jain M, Nanda R. (2012). Etiology and management of impactions of permanent maxillary ca-nines. American Journal of Orthodontics and Dentofacial Orthopedics, 142(6), 804-809.
6. Müller TP, Zimmer M. (2010). Supernumerary teeth: Their prevalence and clinical management. Journal of Clinical Dentistry, 21(2), 104-111.
7. Lione R, Franchi L, Laganà G, Cozza P (2015). Effects of cervical headgear and pendulum ap-pliance on vertical dimension in growing subjects: a retrospective controlled clinical trial. European Journal of Orthodontics 37(3):338 - 3441. https://doi.org/10.1093/ejo/cju061
8. Becker A. The orthodontic treatment of impacted teeth, 1998
9. Betts A, Camilleri GE. A review of 47 cases of unerupted maxillary incisors. International Journal of Paediatric Dentistry. 1999;9:285-292. https://doi.org/10.1111/j.1365-263X.1999.00147.x
10. Jones JW. A Medico-legal Review of Some Current UK Guidelines in Orthodontics: A personal View. J Orthod. 1999;26:307-324. doi: 10.1093/ortho/26.4.307 https://doi.org/10.1093/ortho/26.4.307
11. Al-Nahedh N. (2002). Prevalence and distribution of impacted teeth in the Saudi population. Journal of Clinical Pediatric Dentistry, 27(3), 319-324.12. Huber KL, Suri L, Taneja P. Eruption disturbances of the maxillary incisors: a literature review 1. J Clin Pediatr Dent. 2008;32(3):221-230 https://doi.org/10.17796/jcpd.32.3.m175g328l100x745
13. Chokron A, Reveret S, Salmon B, Vermelin L. Strategies for treating an impacted maxillary cen-tral incisor. Int Orthod. 2010 Jun;8(2):152-176 https://doi.org/10.1016/j.ortho.2010.03.001
14. Smailiene D, Sidlauskas A, Bucinskiene J. Impaction of the central maxillary incisor associated with supernumerary teeth: initial position and spontaneous eruption timing. Stomatologija. 2006;8(4):103-107
15. Pavoni C, Mucedero M, Laganà G, Paoloni V, Cozza P. Impacted maxillary incisors: diagnosis and predictive measurements. Ann Stomatol (Roma). 2012 Jul;3(3-4):100-5
16. Ericson S, Kurol J. Early treatment of palatally impacted maxillary erupting canines by extrac-tion of the primary canines. Eur J Orthod 1988;10:283-95. https://doi.org/10.1093/ejo/10.1.283
17. Baccetti T, Mucedero M, Leonardi M, Cozza P. Interceptive treatment of palatal impaction of maxillary canines with rapid maxillary expansion: a randomized clinical trial. Am J Orthod Dentofa-cial Orthop. 2009 Nov;136(5):657-61 https://doi.org/10.1016/j.ajodo.2008.03.019
18. Ballanti F, Lione R, Fiaschetti V, Fanucci E, Cozza P. (2008). Low-dose CT protocol for ortho-dontic diagnosis. European journal of Paediatric Dentistry 9(2):65 - 70
19. Sawamura T, Minowa K, Nakamura M. Impacted teeth in the maxilla: usefulness of 3D dental-CT for preoperative evaluation. Eur J Radiol. 2003;47:221-226. https://doi.org/10.1016/S0720-048X(02)00168-7
20. Chen Y, Duan P, Meng Y, Chen Y. Three-dimensional spiral computed tomographic imaging: a new approach to the diagnosis and treatment planning of impacted teeth. Am J Orthod Dentofacial Orthop. 2006 Jul;130(1):112-116 https://doi.org/10.1016/j.ajodo.2006.02.024
21. Walker L, Enciso R, Mah J. Three-dimensional localization of maxillary canines with cone-beam computed tomogra-

phy. Am J Orthod Dentofacial Orthop. 2005 Oct;128(4):418-423 https://doi.org/10.1016/j.ajodo.2004.04.033
22. Kaugars GE, Glickman I. (2001). The management of impacted third molars. Journal of the American Dental Association, 132(9), 1324-1331.23. Scarfe, W. C., & Farman, A. G. (2008). What is Cone-Beam CT and How Does it Work? Dental Clinics of North America, 52(4), 707-730.) https://doi.org/10.1016/j.cden.2008.05.005
24. Kapila, S. D., Nervina, J. M. 2011. CBCT in orthodontics: assessment of treatment outcomes and indications for its use. Dentomaxillofacial Radiology, 40(4), 208-214.25. Kokich VO, Kinzer GA. (2017). Managing impacted teeth. The Journal of Clinical Orthodontics, 51(8), 462-469.26. Cotrin P, Freitas KMS, Freitas MR, Valarelli FP, Cançado RH, Janson G. (2020) Evaluation of the influence of mandibular third molars on mandibular anterior crowding relapse. Acta Odontol Scand. May;78(4):297-302. https://doi.org/10.1080/00016357.2019.1703142
27. Severt TL. Proffit WR. (2003). The management of impacted canines. American Journal of Or-thodontics and Dentofacial Orthopedics, 123(5), 514-520.28. Zawawi KH, Melis M. (2014) The role of mandibular third molars on lower anterior teeth crowd-ing and relapse after orthodontic treatment: a systematic review. Scientific World Journal. 2014:615429. https://doi.org/10.1155/2014/615429
29. Jacobson, A. (2007). The impact of orthodontic treatment on impacted teeth. Seminars in Ortho-dontics, 13(2), 88-98.
30. Stanaitytė R, Trakinienė G, Gervickas A. (2014) Do wisdom teeth induce lower anterior teeth crowding? A systematic literature review. Stomatologija;16(1):15-8.PMID: 24824055 Review.
31. Izzi F.; Frijo G.; Romito M.; Benvenuti C.C.; Izzi G.; Severino M.; Nagni M.Orthodontic approach in patients with osteogenesis imperfectaORAL and Implantology, Vol. 16 No. 1 (2024), https://doi.org/10.11138/oi16129-31 https://doi.org/10.11138/oi16129-31
32. Matteo Nagni, Marco Severino, Lorenzo Redi, Agostino Zizza, Gian Luca Pancrazi, Emilio Vav-assori, Bianca D'OrtoPossible complications in oral surgery and their management in patients affected by type 1 diabetes: narrative reviewORAL and Implantology, Vol. 16 No. 1 (2024) https://doi.org/10.11138/oi16132-37 https://doi.org/10.11138/oi16132-37
33. Irene Cusenza, Vittorio Pensa, Sofia Rastelli, Chiara Galati, Stefano Cogotzi, Bianca D'Orto, Matteo Nagni Conscious sedation in dentistry: narrative review ORAL and Implantology, Vol. 16 No. 1 (2024), https://doi.org/10.11138/oi1617-13 https://doi.org/10.11138/oi1617-13
34. Manica U.; Izzi F.; Palmacci M.; Rastelli S.; Ceresoli L.; Balbi B.; Nagni M. Implant-prosthetic rehabilitation of an agenesis lateral incisor: a case report and literature review ORAL and Implantology, Vol. 16 No. 1 (2024), https://doi.org/10.11138/oi16114-18 https://doi.org/10.11138/oi16114-18