gemeente **Barneveld**

Zaaknr. 1111529

Collegevoorstel

**Onderwerp**:
Memo ter beantwoording van vragen over de toepassing van val- en speelzand op speelplekken.

**Gevraagde beslissing**:

1. Instemmen met de memo: beantwoording van vragen over de toepassing van val- en speelzand op speelplekken.
2. Het besluit ter kennisname aan de raad te sturen via rubriek B.

**Raad**
☐ Ter kennisname naar de raad
Nummer beleidsproduct:
☐ Op overzicht Bestaand beleid (website)

Datum: 28 mei 2019 Steller: C. Vogel

Afd: Beheer Openbare Ruimte Aantal bijlagen 5

Afd.hoofd: – Portefeuillehouder A.H. van de Burgwal

**Openbaarheid**

| | | |
|---|---|---|
| Besluit (voorblad) openbaar: | ◉ Ja | ○ Nee, zie beslispunt : |
| Groentje openbaar: | ◉ Ja | ○ Nee, zie beslispunt : |
| Bijlagen openbaar: | ◉ Ja | ○ Nee, vermelden op bijlage |

| | Akkoord | Bespreken | Aantekeningen |
|---|---|---|---|
| Secretaris | | | |
| Burgemeester | | | |
| Wethouder A. de Kruijf | | | |
| Wethouder P.J.T. van Daalen | | | |
| Wethouder A.H. van de Burgwal | | | |
| Wethouder D. J. Dorrestijn-Taal | | | |

**Beslissing burgemeester en wethouders** :
conform advies
ij

Nummer op besluitenlijst: 25/04

BIJLAGE

Vragen van het lid Koşer Kaya (D66) aan de Staatssecretaris van Economische Zaken en de Minister van Volksgezondheid, Welzijn en Sport over besmette zandbakken in speeltuinen (ingezonden 15 juni 2016).

Antwoord van Minister Schippers (Volksgezondheid, Welzijn en Sport) (ontvangen 4 juli 2016).

**Vraag 1**

Bent u bekend met de uitzending van «Smerige zaken» waarin de veiligheid van zandbakken in speeltuinen aan de orde wordt gesteld?[1]

**Antwoord 1**

Ja.

**Vraag 2**

Hoe groot is de kans voor kinderen op besmetting met de parasieten toxoplasmose en/of toxocariasis door het spelen in een openbare speeltuin waaruit niet geregeld dierlijke poep verwijderd wordt? Is dat substantieel groter of kleiner dan speeltuinen waar dit wel gebeurt? Zo ja, op welke wijze precies?

**Antwoord 2**

Toxocara wordt zowel door katten (Toxocara catie) als honden (Toxocara canis) uitgescheiden. Contact met aarde, waaronder spelen in zandbakken, en contact met katten is een risicofactor voor Toxocara. Onderzoeken in zandbakken toonden Toxocara eieren in ongeveer 30% van de zandbakken aan (onderzoek in 2014 in drie gemeenten).

Toxoplasma wordt overgedragen door zowel kattenpoep als via vlees. Het relatieve belang van de verschillende routes van overdracht voor Toxoplasma infecties bij de mens wordt op dit moment onderzocht door het RIVM. Uit studies in de Nederlandse bevolking blijkt dat het spelen in zandbakken en het in de mond stoppen van zand een risicofactor is voor Toxoplasma.

De kans op besmetting door het spelen in een openbare speeltuin waar poep van honden en katten wel of niet wordt verwijderd, is niet onderzocht. De mate van vervuiling was wel afhankelijk van het al dan niet afdekken van de zandbak.

**Vraag 3**

Hoeveel gevallen zijn u jaarlijks bekend? Hoe is het ziekteverloop bij deze ziekten en hoe groot is de kans op blijvende schade?

**Antwoord 3**

Er bestaat geen meldingsplicht voor Toxoplasma of Toxocara. Er is dus geen overzicht van het aantal gevallen.

Overigens verlopen de meeste infecties met deze parasieten asymptomatisch. Dit betekent dat de kinderen wel besmet zijn maar daar geen last van hebben. Als een infectie met Toxoplasma klachten geeft dan worden vooral lymfeklierzwellingen gezien, oogafwijkingen en langdurige vermoeidheid. Afhankelijk van de plaats in het oog kan de infectie tot verlies van het gezichtsvermogen leiden. In uitzonderingsgevallen worden er ernstige symptomen gezien zoals encefalitis (hersenontsteking). Bij mensen met immuunstoornissen kan de infectie tot ernstige ziekte leiden met blijvende schade.

Bij een infectie met Toxocara kunnen de symptomen bestaan uit astma-achtige verschijnselen, afwijkingen aan de longen en eosinofilie (afwijkende cellen in het bloed). Bij een aantal patiënten kan een ooginfectie optreden. Er zijn geen gegevens bekend over blijvende schade. Een zeer klein aantal patiënten kan neurologische afwijkingen krijgen.

Studies van het RIVM uit 1996 liet zien dat 15% van de kinderen tussen 0–5 jaar antistoffen tegen Toxoplasma hadden. Van deze leeftijdsgroep had 5.5% antistoffen tegen Toxocara. Voor kinderen van 6–15 jaar is dit 14% voor Toxoplasma en 16% voor Toxocara. Dit betekent dat deze kinderen de infectie hebben doorgemaakt. In 2006 is dit gedaald naar 9% voor Toxoplasma en 4% voor Toxocara bij de kinderen tussen 0–5 jaar en 9% voor Toxoplasma en 7% voor Toxocara bij de kinderen van 6–15 jaar. Deze gegevens laten zien dat het aantal besmettingen is afgenomen.

**Vraag 4**

Is het waar dat de Nederlandse Voedsel- en Warenautoriteit toezicht houdt op de veiligheid van de speeltoestellen zelf, maar het beheer van en toezicht op de ondergrond geheel overlaat aan de eigenaar van de speeltuin? Zo ja, welke redenering ligt daaraan ten grondslag? Zo nee, hoe is de toezichtsverdeling dan wel geregeld?

**Antwoord 4**

In het Warenwetbesluit attractie- en speeltoestellen is geregeld dat degene die een attractie- of speeltoestel voorhanden heeft, ervoor zorgt dat het toestel zodanig is geïnstalleerd, gemonteerd en zodanig is beproefd, geïnspecteerd en onderhouden en zodanig van opschriften is voorzien, dat er bij gebruik geen gevaar voor de gezondheid of veiligheid van personen bestaat. Dit geldt ook voor het bodemmateriaal. De NVWA ziet toe op het naleven van die verplichtingen door de eigenaren van de speeltoestellen.

**Vraag 5**

Bent u bereid in overleg te gaan met de NVWA en gemeenten om waar nodig en mogelijk risico's op besmetting te verkleinen?

**Antwoord 5**

De eigenaar en beheerder kunnen zich informeren via www.allesoverspelen.nl en http://www.regelhulpenvoorbedrijven.nl/Speeltoestellen.

Advies aan de ouder is om je kind alleen in de zandbak te laten spelen en niet in zand dat dient als valdemping onder speeltoestellen. De kans dat je in een zandbak schoon zand treft is veel groter dan onder een speeltoestel. Spelen in het zand onder een speeltoestel heeft verder als risico dat een kind gewond raakt door bijvoorbeeld een schommel. En als de speelplek smerig is neem dan eerst contact op met de beheerder/gemeente. En bovenal: laat kinderen voor het eten en na het buiten spelen hun handen goed wassen.

# Advies inzake Zandondergronden

## Gemeente Edam-Volendam

Ingenieursbureau
specialisten in speelruimte

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## 1. AANLEIDING

Naar aanleiding van de uitvoering van het speelruimteplan vervangt gemeente Edam-Volendam een groot gedeelte van haar ondergronden bij speeltoestellen met valdempend zand. Hiertegen namen enkele burgers het initiatief om bezwaar te maken. Met dit bezwaar willen ze bereiken dat de gemeente geen zand als valdempende ondergrond toepast, maar kiest voor gras en/of rubbertegels. Argumenten zijn met name aspecten betreffende hygiëne (toxoplasma), kosten en overlast.

Vooropgesteld wordt dat spelen veilig moet zijn en spelen in uitwerpselen van kat, hond of enig ander dier nooit fris is. Tijdens rondgangen met kinderen is hondenpoep een van de meest gehoorde klachten van de jeugd.

## 2. PROCES/OPBOUW ADVIES

Het speelruimteplan, de brief en overige stukken zijn zorgvuldig doorgenomen. Hierin wordt een veelheid van gegevens uit verschillende bronnen aangehaald of er wordt naar verwezen. Omdat diverse zaken daarbij door elkaar lijken te lopen zetten we allereerst wat relevante aspecten en feiten op een rijtje, zoveel mogelijk gestaafd met bronvermelding + deskundigheid/functie. Ook wordt ingegaan op de afweging van mogelijkheden en risico's van verschillende valdempende ondergronden. Aan de hand hiervan volgt het onafhankelijk advies van OBB, specialisten in speelruimten.



# 3. ENKELE RELEVANTE ASPECTEN

## 3.1. Wettelijke eisen aan zand

(Jan Ooms, prominent lid normcommissie CEN en NEN, 1 juni 2011)

*Er zijn geen wettelijke eisen of normen hetzij aan valdempend zand, noch aan zandbakkenzand.* Hetgeen hierover wel beschreven is, heeft betrekking op korrelgrote en mate van aanwezigheid van slib- en kleideeltjes die de valdemping verminderen.

Wel zijn er diverse rapporten van GGD's die het een en ander aan richtlijnen geven over zandbakkenzand. Veelal zijn dit verzamelde algemene teksten uit diverse bronnen.

Door de professionals rondom buitenspelen wordt onderkend dat zandbakken een hogere mate van onderhoud zouden moeten hebben dan valdempend zand, alsook dat zandbakkenzand bij voorkeur "stapelbaar" is om er taartjes mee te kunnen bakken en valdempend zand bij voorkeur juist rond(er) is.

## 3.2. VWA en RIVM

### 3.2.1. Handhaving door VWA

Er is geen geval bekend dat de nieuwe Voedsel- en WarenAutoriteit (VWA) bij controle een speeltoestel buiten gebruik heeft gesteld naar aanleiding van (vermoeden van) aanwezigheid van biologische verontreiniging van de ondergrond.

### 3.2.2. VWA onderzoek Zandbakken

Wel is op de site van VWA het onderzoek "Zandbakken, zware metalen en microbiologische besmetting" te vinden In Bijlage I is hiervan een gedeelte opgenomen.

Hierin staat in de conclusies opgenomen: "…. geeft de microbiologische kwaliteit van het zand geen aanleiding tot zorg voor de spelende kinderen."

### 3.2.3. Onderzoek "Staat van zoönosen 2009"

In opdracht van de nVWA werd door het RIVM een onderzoek verricht naar de "Staat van zoönosen 2009" in het kader van project V/330131/01/ZR: © RIVM 2010. Dit rapport is te vinden via www.vwa.nl/txmpub/files/?p_file_id=2200194 Op pagina 39 daarvan: "Toxoplasma gondii is een veel voorkomende eencellige parasiet, die vooral wordt gevreesd … te ontwikkelen.

In principe zal bij vrouwen die al eens in hun leven (ongemerkt) met Toxoplasma besmet zijn geraakt geen besmetting van het ongeboren kind optreden, omdat de moeder en het ongeboren kind dan al beschermd worden door antistoffen tegen de parasiet. Uit de PIENTER studie blijkt dat de seroprevalentie van antistoffen tegen Toxoplasma gondii sterk is gedaald tussen 2007 (26,0%) en 1996 (40,5%). Risicofactoren voor besmetting met Toxoplasma gondii blijken nog grotendeels hetzelfde als in 1996, met enkele nieuwe risicofactoren die in 2007 voor het eerst nagevraagd werden, zoals het eten van varkensvlees en het in de mond stoppen van zand tijdens het spelen in de zandbak.

De seroprevalentie onder vrouwen in de vruchtbare leeftijd is gedaald van 34,7% in 1996 naar 18,5% in 2007. *Er is dus een grotere populatie vrouwen die tijdens hun vruchtbare leeftijd nog niet aan Toxoplasma gondii zijn blootgesteld en daardoor nog vatbaar zijn voor een eerste infectie tijdens de zwangerschap.* "

3.2.4. Het RIVM, rapport Toxoplasmose
http://www.rivm.nl/cib_xda/protocollen/toxoplasmosepda.html
In het rapport Toxoplasmose op de site van het Rijksinstituut voor Volksgezondheid en Milieu:

*4.2 Besmettingsweg*
*Het is niet bekend of zandbakken met infectieuze oöcysten een rol spelen bij de transmissie van Toxoplasma.*
…
*9.5 Wering van werk, school of kinderdagverblijf*
*Wering is vanuit volksgezondheidsperspectief niet zinvol.*

In andere stukken van RIVM met betrekking tot preventie wordt met name gewezen op de eigen verantwoordelijkheid van ouders, zoals *het afdekken van zandbakken wanneer er geen toezicht is zodat er geen dieren in kunnen*. En *mensen met honden of katten, zeker van jonge dieren, moeten hun dieren regelmatig ontwormen. Vraag hiervoor advies aan de dierenarts*.

3.2.5. Wikipedia
Symptomen. De meeste mensen merken weinig tot niets als ze geïnfecteerd worden, symptomen blijven uit of doen denken aan een griepje. ... Doch ernstige symptomen komen voor, vaak bij mensen met een verminderde weerstand. Dit zijn bijvoorbeeld: koorts, algemene malaise, ooginfectie, lever- en miltvergroting en huiduitslag.
Slechts bij een klein deel van de patiënten met een primaire infectie zal zich een ernstige manifestatie van de ziekte voordoen zoals: beschadigingen aan onder andere de hersenen en het netvlies.
De afgelopen jaren zijn aanwijzingen gevonden dat Toxoplasma-infectie geassocieerd is met een verandering in persoonlijkheidskenmerken en een verminderd psychomotorisch vermogen. Enige tientallen procenten van de bevolking hebben antistoffen tegen de parasiet en zijn er dus ooit mee besmet geweest. De meesten hebben daar nooit iets van gemerkt. De infectie blijft levenslang bestaan maar bij een normaal functionerend immuunsysteem wordt hij niet meer actief.

## 3.3. Speelgedrag

### 3.3.1. Spelen met zand

*spelen met zand naast speelplek*

"Kinderen zullen wroeten,
katten zullen poepen"

Vrijwel alle professionals die betrokken zijn bij spelen zijn het er over eens: naast water is zand een van de belangrijkste speelmiddelen van een kind. Niet alleen voor zijn of haar plezier, maar ook voor de ontwikkeling van motorische en cognitieve vaardigheden.
Voor kinderen lijkt het spelen met zand een aangeboren eigenschap te zijn. Daar waar kinderen de kans hebben zie je ze spelen met zand. Een aardig voorbeeld is dat we regelmatig plekken tegenkomen waar bijvoorbeeld rubbertegels of kunstgras zijn aangelegd en waar direct ernaast de kinderen het zand loskrabben. Maar ook als er een stukje grasveld is losgewoeld, in de boomspiegel of het plantsoen zie je jonge kinderen het zand voelen, proeven, kneden en leren gebruiken.
Indien ouders niet willen dat hun kind aan mogelijke verontreinigingen bloot worden gesteld, zullen ze dus hetzij moeten voorkomen dat hun kind met zand in de openbare ruimte speelt, hetzij een hoge mate van "handenwassen" moeten invoeren.
In het algemeen wordt voor wat betreft de leeftijd tot en met circa 3 jaar bij spelen van uitgegaan dat ouders volledig toezicht houden/weten wat hun kind doet en waar het is. De ouders schatten daarbij risico's en (on)gewenste situaties in. Vanaf een jaar of 4 krijgen de kinderen meer zelfstandigheid, stoppen ze niet zomaar meer iets in de mond en kunnen ze geleerd hebben wat ouders wel of niet toestaan.

Bij spelen wordt nadrukkelijk onderscheid gemaakt tussen zandbakken en valdempend zand. Niet alleen het type zand verschilt, maar bij zandbakken worden hogere eisen gesteld aan onderhoud en mate van verontreiniging.
Dat kinderen met het valdempend zand kunnen spelen wordt niet gezien als een argument om valdempend zand als zandbak te gaan onderhouden. Er wordt daarbij wel vergelijk gemaakt met het zwemmen in oppervlaktewater en in het zwembad: kinderen (en volwassenen) zwemmen bijvoorbeeld in sloten, vaarten, kanalen, poelen, plassen, rivieren en fonteinen. Hoewel de eigenaar op de hoogte is van dit gebruik, hoeft hij niet te voldoen aan de eisen van bijvoorbeeld een zwembad.

### 3.3.2. Trend natuurlijk spelen

Steeds meer aanbieders van speelruimte als gemeenten, scholen, buitenschoolse opvang, recreatiesector, StaatsBosBeheer en Natuurmonumenten zetten in op natuurlijk spelen. Bij dergelijke speelplekken, schoolpleinen en speelbossen wordt veel gewerkt met natuurlijke materialen als water, zand als bouwmateriaal, struiken, takken en bladeren, vruchten, boomstammen, moestuinen enzovoort.

Deze trend wordt sterk ondersteund door diverse recentere onderzoeken en de toepassing van bestaande wetenschappelijke onderzoeken waarin aangetoond wordt dat "groen gezond is", dat kinderen die in een minder steriele omgeving opgroeien, zoals op boerderijen, minder klachten hebben als bijvoorbeeld astma, eczeem en hooikoorts.

## 3.4. Beheer en onderhoud

### 3.4.1. Inspecteren

Nadat een speeltoestel geplaatst is moet deze worden geïnspecteerd. Daarbij wordt gekeken of het toestel en zijn ondergrond nog voldoen aan hetgeen in het bijbehorende certificaat beschreven. Inspecteren van een speeltoestel moet "*zo vaak als* nodig is" (Jeroen Bos Keurmerkinstituut certificeerder, opleider / Secretaris Stichting Veilig Spelen). De frequentie van inspectie hangt af van het type toestel, de plaats en de omstandigheden. Dit in tegenstelling tot zoals in het verleden veelal werd geadviseerd, ook door OBB, om uit te gaan van een maandelijkse, kwartaal- en jaarlijkse inspectie, naast dagelijkse visuele inspecties; voor sommige toestellen in bepaalde situaties is dat te weinig, voor andere situaties veel vaker dan noodzakelijk.

Ongeacht welk type ondergrond aanwezig is, dient bij een inspectie van een speeltoestel te worden meegenomen of er objecten in de valzone voorkomen waar een kind ernstig en blijvend letsel door kan oplopen. Daarbij wordt in de praktijk voornamelijk gekeken naar glas, naalden, stokken en een enkele maal maakt een inspecteur opmerkingen over de aanwezigheid van andere verontreinigingen, zoals onkruid of katten- en hondenpoep.

### 3.4.2. Stomen van zand

(ir. D. Vermeulen, stedenbouwkundige, sinds 1992 speelruimteadviseur, 1 juni 2011)

In de jaren 70/80 zijn in Rotterdam proeven gedaan naar stomen van zandbakkenzand. Daaruit bleek dat de onderzochte ziektekiemen voor het stomen met redelijk hoge waarden aanwezig waren. Direct na het stomen waren deze waarden op nul, echter na een tot enkele dagen ontstaat een explosie van ontwikkelingen waarbij 10 tot 100 keer de aanvankelijk waarden zijn waargenomen.
Belangrijkste conclusies van dergelijke onderzoeken zijn dat het zelfreinigend vermogen van het zand groter is als het natuurlijk evenwicht in stand wordt gehouden, er een goede waterdoorlatendheid is en dat bezonning (UV) sterk positief bijdraagt aan het voorkomen van exponentiële kiemgroei.

3.4.3. Zeven van zand

Verscheidene gemeenten reinigen een keer per jaar hun zandbakken en valdempende ondergronden door middel van zeven. Hiermee worden verontreinigingen als glas, stokjes, peuken en andere harde objecten weggezeefd. Verder claimen leveranciers van deze methode dat dit bijdraagt aan het natuurlijk zelfreinigend vermogen van het zand. Dit is op zich aannemelijk, gezien de beluchting die plaatsvindt (bestrijding anaerobe kiemen). Concrete en gerichte onderzoeken heeft OBB echter nooit ontvangen of kunnen inzien.

## 3.5. Benchmark andere gemeenten

3.5.1. Toepassing zand bij gemeenten

Vanuit de circa 150 speelruimte- of beheerplannen die OBB mocht opstellen, blijkt dat minimaal de helft van de 418 Nederlandse gemeenten zand tenminste bij een gedeelte van hun speelplekken toepast als valdempende ondergrond. Er is geen gemeente bekend waar valdempend zand structureel gestoomd wordt. Van de gemeenten die structureel valdempend zand toeppassen, zeven naar inschatting maximaal 5 tot 10% het zand jaarlijks.

Uit beheercijfers blijkt dat geen van de gemeenten waar valdempend zand is aangelegd bijzonder hoge kosten heeft voor het beheer en onderhoud ervan.

3.5.2. Toepassen zandbakken

Wel zijn er veel gemeenten die de zandbakken in de openbare ruimte hebben opgeruimd in verband met onderhoudskosten (en omdat deze veelal in de 60- en 70-er jaren zijn aangelegd en er inmiddels niet veel kinderen meer in die buurten wonen.
Momenteel komen de meeste zandbakken voor bij hoogbouw.

3.5.3. Ontwerpen van speelplekken

In de afgelopen tien jaren is meer aandacht gekomen voor het echt ontwerpen van de speelplekken ten opzichte van het eenvoudigweg plaatsen van speeltoestellen in de openbare ruimte. Bij deze ontwerpen door de landschapinrichters wordt meer dan vroeger gekeken naar andere speelmogelijkheden die geboden kunnen worden met groen, heuvels, water, zand en vruchten.

Ook wordt meer dan voorheen vanuit esthetische oogpunten nagedacht over het gebruik van bodemmaterialen en hoe dit in de omgeving en het spelen past. Dit heeft ertoe geleid dat binnen steeds meer gemeenten diverse soorten ondergronden worden toegepast, afhankelijk van de situatie en omgeving.

## 3.6. Kostenvergelijkingen

3.6.1. Ervaringscijfers

Uit beheercijfers (zie ook 3.5.1) blijkt dat geen van de gemeenten waar valdempend zand is aangelegd bijzonder hoge kosten heeft voor het beheer en onderhoud ervan.

3.6.2. Algemeen en specifiek

Bij kostenvergelijkingen en gebruik van kengetallen is een gevaar dat algemene uitgangspunten bijvoorbeeld van toepassing worden verklaard op een geheel, terwijl specifieke situaties en de uitgangssituatie in het algemeen soms niet of moeilijk vergelijkbaar zijn en er niet gedifferentieerd kan worden per situatie of locatie. Bij een zandondergrond in een geheel verharde omgeving zonder hoge opsluitranden zal bijvoorbeeld rekening moeten worden gehouden met het terugvegen van zand, terwijl dit in een grasomgeving niet nodig zal zijn.
Veel is ook afhankelijk van het gekozen onderhoudsniveau, dat per gebied kan verschillen; zo mag in veel gemeenten bijvoorbeeld op een zichtlocatie geen/weinig zwerfvuil liggen, terwijl in andere buurten een bepaalde mate van vervuiling wordt toegestaan.
Een belangrijk uitgangspunt kan zijn dat in de ramingen ook de stortkosten na levensduur meegerekend worden.

Bij de calculatie van gras als valdempend materiaal moet, afhankelijk van de maaiwijze (machinepark), de onderhoudsniveaus en de soorten speeltoestellen (bv gras onder een huisje op palen) die zijn geplaatst rekening worden gehouden met circa 23 maal per jaar maaien, plus obstakelmaaien.

## 3.7. Afweging van risico's

Veiligheid gaat over het afwegen van risico's. Er is namelijk geen enkele mogelijkheid een situatie te creëren waarbij alle risico's zijn uitgesloten.

3.7.1. Valdempende materialen

In het Nieuwe Bijblad van de norm NEN-EN 1176 (per 8 juni 2011) is een indicatieve tabel opgenomen (zie ook Bijlage II). Daarmee is vastgelegd dat een grasmat voldoende valdempende eigenschappen zal hebben tot anderhalve meter. In deze nieuwe tabel is aarde –om nog onbekende reden- niet opgenomen. In oudere versies van deze tabel werd bij aarde uitgegaan van 1 meter.
Belangrijk is om op te merken dat de valdempende eigenschappen van gras vooral ontstaan door het wortelpakket en niet door de spriet. Dit betekent dat een speelplek kaal gespeeld kan worden, indien het gras tussentijds maar weer voldoende tijd krijgt om te herstellen.
Dit betekent dat bij het toepassen van gras bij de inspectie in de gaten moet worden gehouden of het gras voldoende blijkt te herstellen. (Alleen) indien dit niet het geval is door hoge speelintensiteit, zal er gekozen moeten worden voor een andere valdempende ondergrond.

### 3.7.2. Gras en ziekte van Lyme

Ook bij gras zijn risico's te verwachten. Zo komen bijvoorbeeld teken voor in gras en die brengen de ziekte van Lyme over. Jaarlijks worden er in Nederland ongeveer 1,2 miljoen mensen gebeten door een teek. Hiervan krijgen er ongeveer 17.000 (bijna 1,5%) Erythema migrans,[3] een scherp afgetekende rode ring rond de plaats van de beet. ( Verschijnselen: Stadium 1: Lokale huidinfectie; erythema migrans (EM), …. Stadium 3: Chronische Lyme-borreliose, Chronische neuroborreliose, Acrodermatitis chronica atrophicans).

### 3.7.3. Rubbertegels

Hoewel met rubbertegels voldaan kan worden aan de bescherming tegen hersenletsel, is van rubber bekend dat er bijvoorbeeld meer kans is op breuk van een arm én op een gecompliceerdere (spiraal)breuk van een arm. Dit doordat bij een val de hand op het ruwe rubber gelijk stilstaat en niet kan doorglijden.

In schaduwrijke omstandigheden zal er rekening mee moeten worden gehouden dat rubbertegels glad kunnen worden door algengroei, waardoor extra risico op uitglijden ontstaat.

Het blijkt dat na verloop van tijd veel rubbertegels opstaande randen krijgen, wat het risico op struikelen vergroot.

### 3.7.4. Milieuaspecten

Bij de keuze van ondergronden kan nog overwogen worden welk beleid de gemeente voert ten aanzien van duurzaamheid. Zand, houtsnippers, boomschors en gras zijn hernieuwbare, $CO_2$ neutrale en eventueel herbruikbare stoffen. Rubbertegels en kunstgras zullen aan het einde van hun levensduur afgevoerd moeten worden.

Rubbergranulaat, waarvan veel rubbertegels gemaakt worden, wordt veelal gemaakt van oude rubberproducten zoals versnipperde autobanden. Uit deze rubberkorrels komen organische verbindingen vrij, waaronder verschillende polycylische aromatische koolwaterstoffen (PAK's) en weekmakers, maar ook metalen, vooral zink. Uit RIVM onderzoek blijkt dat ook nitrosaminen in zeer geringe mate vrijkomen uit rubberkorrels.

In juni 2006 heeft het RIVM een beknopt rapport uitgebracht over de gezondheids- en milieueffecten van rubberkorrels op kunstgrasvelden. Hierbij zijn polycyclische aromatische koolwaterstoffen (PAK's) en weekmakers bestudeerd. Deze stoffen vormden geen risico voor de gezondheid voor mensen die sporten op kunstgrasvelden met rubberkorrels. Het RIVM kwam tot de conclusie dat naast zink ook voor andere stoffen de milieukwaliteitsnorm kan worden overschreden.

### 3.8. Visie OBB bij keuze valdempende ondergrond

Uitgangspunt van OBB bij de keuze voor een bepaald type speeltoestel en (valdempende) ondergrond is maatwerk per locatie. Daarbij zal aan de hand van de doelgroep gekeken moeten worden naar passende bespeelbaarheid, speelmogelijkheden en het kostenaspect. In eerste instantie zal de keuze gebaseerd moeten worden op het *ontwerp* van de speelplek en het *doel* van de speelplek.
Het Nieuwe Bijblad 8 juni 2008 versterkt de visie om gras als valdemping toe te passen daar waar het kan, en niet te meer doen dan wettelijk nodig is. Daar waar het wortelgestel voldoende in stand blijft kan gras tot 150 cm toegepast worden.
Indien de valhoogte valdemping noodzakelijk maakt, hoeft niet meer valdemping gerealiseerd te worden dan in het certificaat omschreven. Eventueel kunnen onderhoudsaspecten en inrichtingstechnische aspecten leiden tot specifieke afwijkingen, bijvoorbeeld om op een speelplek (uitgaande van het hoogste toestel) op een speelplek eenzelfde valdempend materiaal toe te passen.
Daarbij kan in de visie van OBB in eerste instantie het beste gekozen worden voor natuurlijke materialen, met gras als eerste voorkeur.
*Indien uit inspecties (of ervaring/inschatting naar aanleiding van speelruimteanalyse van de doelgroep) blijkt dat de speelplek zodanig wordt bespeeld dat een grasmat niet in stand blijft, kan gekozen worden voor zand of eventueel houtsnippers of boomschors.

* Indien uit inspecties (of eventueel concrete ervaringen in de betrokken buurt) blijkt dat zand op die bepaalde locatie zeer vervuild wordt, kan gekozen worden voor een andere ondergrond.
* Losse valdempende materialen zijn minder geschikt in een (zeer) stenige omgeving in verband met verspreiding ervan door de buurt.
* Op schaduwrijke plekken, plekken waar veel vuil/bladeren/-takken vallen, waar de ondergrond onvoldoende doorlatend is om voldoende natuurlijk zelfreinigend vermogen te bereiken, kan voor een vaste ondergrond (bijvoorbeeld rubbertegels of kunstgras) gekozen worden.

## 4. ADVIES OBB INZAKE EDAM-VOLENDAM

OBB adviseert wat betreft het toepassen van valdempend zand en het burgerinitiatief maatwerk per speelplek te leveren, uitgaande van waar mogelijk gras en valdempend zand.

Hiermee wordt gedeeltelijk invulling gegeven aan het burgerinitiatief (meer plekken met gras) onder een beperkte stijging van kosten door aanleg van rubbertegels.

Aan de hand van een deel van de foto's van speelplekken in Edam-Volendam is ingeschat dat een deel van de speelplekken zo intensief worden bespeeld dat het wortelpakket te weinig kans maakt. Daar zal afhankelijk van de valhoogte en omstandigheden zand of een vaste ondergrond toegepast moeten worden.

Bij toestellen tot 150 cm:
uitgaande van stand van zaken uitvoering:
* als er nu nog gras ligt, gras laten. Indien uit huidige of toekomstige inspecties blijkt dat er te veel belasting is van het wortelpakket dan in principe naar zand.
* als er al nu zand is aangebracht, gewoon met zand doorgaan. Mocht het a. een stenige omgeving betreffen (uitloop) of b. uit huidige of toekomstige inspecties te veel vervuiling blijken of c. te donker zijn, dan bijmengen compost plus inzaaien graszaad.

Bij toestellen hoger dan 150 cm:
* in principe zand toepassen, mocht het a. een stenige omgeving betreffen (uitloop) of b. uit huidige of toekomstige inspecties te veel vervuiling blijken of c. te donker zijn, dan keuze maken: vaste valdempende ondergrond/rubbertegels of kunstgrasmat, afhankelijk van locatie).

*Geen speelschade*

Verder adviseert OBB:
➔ niet in te gaan op de aspecten rond hygiëne. Het VWA en RIVM stellen dat microbiologische kwaliteit geen zorg geeft voor spelende kinderen.
➔ niet in te gaan op aspecten van kosten. Dit is primair een eigen verantwoordelijkheid van de gemeente en daarbij wijzen ervaringen van veel andere gemeenten uit dat geen hoge onderhoudskosten ontstaan bij het toepassen van valdempend zand.

**BIJLAGE I.** **VWA OVER ZANDBAKKEN**

http://www.vwa.nl/txmpub/files/?p_file_id=10848

# ZANDBAKKEN

Zware metalen en microbiologische besmetting

Rapport nummer: NDTOY004/01

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## 5. CONCLUSIES

Het zandbakken zand voldeed ruimschoots aan de limieten gesteld voor een schone grond verklaring en gezondheidskundige grenswaardes, in zake het lood, kobalt, chroom, nikkel, en cadmium gehalte. Wanneer wordt vergeleken met de normen voor speelgoed, was het chroom gehalte van al het zand gemiddeld een factor 3 te hoog. Wat betreft lood en cadmium gehalte voldeed het merendeel aan de speelgoed norm. Het gehalte aan zware metalen in zandbakken zand levert geen gevaar op voor de gezondheid van de spelende kinderen.

Het totaal kiemgetal van het zand was in de orde grootte van $10^5$-$10^6$ kve/g. Gisten en schimmels waren aanwezig, tot $10^4$ kve/g. Sporen van *Clostridium* en *Bacillus* werden aangetoond in het zand en waren in de orde grootte tot $10^3$ kve/g aanwezig. In 3 van de 17 zandbakken werden *Enterobacteriaceae* aangetroffen. *Salmonella* en *Campylobacter* waren niet aantoonbaar aanwezig. Gezien de lage inname van zand (0.2 g per dag) geeft de microbiologische kwaliteit van het zand geen aanleiding tot zorg voor de spelende kinderen.

Ten opzichte van normale grond (bos, tuin) had het zandbakken zand een lager gehalte aan zware metalen. Het totaal kiemgetal was ten opzichte van zandbakken iets lager, de grondmonsters bevatten echter een hoger aantal gisten en schimmels. Ook de onderzochte normale grond levert geen gevaar op voor de gezondheid van kinderen, wat betreft gehalte zware metalen en microbiologische besmetting.

## BIJLAGE II. BIJBLAD NEN-EN 1176 TOELICHTING VOOR NORMGEBRUIKERS

8 juni 2011

http://www.nen.nl/web/file?uuid=74c2d200-d1bd-4641-be30-5a60df8a4176&owner=e107a775-ee12-4fac-bdc8-b89d02d99e18

De in Tabel 4 'Voorbeelden van algemeen toegepaste schokabsorberende materialen, diepten en overeenkomstige kritische valhoogten' genoemde valhoogte op gras wordt gewijzigd van 1 m naar 1,5 m, zulks conform de situatie in ons omringende landen en ondersteund door proefresultaten. Hiermee wordt bedoeld een terdege gewortelde grasmat. In de meeste gevallen is gras als valondergrond dus tot een valhoogte van 1,5 m toegestaan, zonder het verrichten van een proef. De vereiste HIC-waarde (≤1000) blijft de geldende waarde.

Op de meeste ondergronden is dat ook het geval. In extreme gevallen zoals bij uitgedroogde zware kleigronden kan nader onderzoek nodig zijn. Overigens is de valdempende kwaliteit van gras vooral te danken aan het wortelgestel. Het zichtbare gras speelt minder een rol.

**Tabel 1 van 'Bijblad' – Voorbeelden voor Nederland van algemeen toegepaste schokabsorberende materialen, diepten en overeenkomstige kritische valhoogten**

| Materiaal [a] | Omschrijving | Laagdikte [b] | Kritische valhoogte |
|---|---|---|---|
| | mm | mm | mm |
| **Grasmat** | | | ≤ 1 500 |
| **Boomschors** | Afmeting delen 20 tot 80 | 200 | ≤ 2 000 |
| | | 300 | ≤ 3 000 |
| **Houtspaanders/ houtsnippers** | Afmeting delen 5 tot 30 | 200 | ≤ 2 000 |
| | | 300 | ≤ 3 000 |
| **Zand** [c] | Korrelgrootte 0,2 tot 2 | 200 | ≤ 2 000 |
| | | 300 | ≤ 3 000 |
| **Grind** [c] | Korrelgrootte 2 tot 8 | 200 | ≤ 2 000 |
| | | 300 | ≤ 3 000 |
| **Overige materialen en diepten** | Naar beproeving volgens HIC (zie NEN-EN 1177) | | Kritische valhoogte volgens beproeving |

[a] Materialen die passend zijn geprepareerd voor toepassing op kinderspeelplaatsen.

[b] Voor losgestort materiaal: verhoog de laagdikte met 100 mm ter compensatie van verplaatsing (zie NEN-EN 1176-1:2008 4.2.8.5.1).

[c] Geen slib- of kleideeltjes. De korrelgrote kan worden bepaald met behulp van een zeefproef, zoals in NEN-EN 933-1.

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**X) Zandbakken**

Zandbakken zonder verhoogde rand hebben geen obstakelvrije valruimte nodig.

Bij zandbakken met een verhoogde rand is een obstakelvrije ruimte wel nodig, echter kan plaatsing direct tegen of zeer nabij een hoog object (bijvoorbeeld gesloten vlakke gevel, boom, paal) een veilige situatie opleveren. De essentie is dat niet op, maar tegen het object gevallen wordt.

GLOBAL WATER PATHOGEN PROJECT

**PART THREE. SPECIFIC EXCRETED PATHOGENS: ENVIRONMENTAL AND EPIDEMIOLOGY ASPECTS**

# TOXOCARA SPP.

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## Summary

Toxocara is a genus of nematodes that are cosmopolitan gastrointestinal species of both companion and feral animals that act as definitive hosts. Toxocara canis infects both domestic dogs and foxes, whereas the hosts of T. cati include the domestic cat and other felids. Widespread environmental contamination, as a consequence of eggs being shed in the host faeces, facilitates infection of abnormal or paratenic hosts, that include mice, domestic animals, and humans. In such hosts, larvae undergo a somatic migration through the tissues and organs of the body but fail to develop to maturity as adult worms in the intestine. The presence of migrating larvae in the tissues contributes to pathology that is dependent upon the intensity of infection and the location of the larvae and is associated with the human disease known as toxocariasis.

Although our understanding of the public health significance of toxocariasis in humans is incomplete, seroprevalence studies provide evidence for high levels of exposure in the human population. Toxocariasis is now considered to be the most common human parasitic infection in the Unites States, particularly among the impoverished. Furthermore, the infection is also common in developing countries and its global importance is likely to be significantly underestimated.

Humans exhibit a number of clinical entities including visceral larva migrans, ocular toxocariasis, and cerebral toxocariasis. Larval involvement in the eye, with consequent visual impairment, remains the most devastating sequela. However, recent evidence from a large-scale sample of American children of an association between seropositivity and cognitive defects may prove to be of even broader public health significance.

One particular lacuna in our knowledge of the epidemiology of toxocariasis is the relative importance of different modes of transmission. Humans become exposed to infection by ingestion of embryonated eggs, either due to handling or consuming contaminated soil or food, or eating meat products containing third-stage larvae.

The literature on environmental contamination with Toxocara spp ova is almost entirely confined to examination of soil. The presence of potentially infective or infective eggs of Toxocara spp. in the environment is one of the key routes of transmission to humans. Infected definitive hosts such as dogs, cats and to a lesser extent foxes release their faeces, and the helminth eggs within them, into the environment. However, our understanding of the relative importance of the different host sources is incomplete. In contrast to soil, few studies have described the recovery of Toxocara eggs from water. In one study from Australia, the highest prevalence of helminth eggs detected in liquid sludge from urban wastewater treatment plants was Toxocara. A recent review of methods for the quantification of soil-transmitted helminthes in environmental samples, highlighted four key methodological issues – environmental sampling, recovery from environmental matrices, quantification, and viability assessment. This chapter will highlight the existing data on environmental contamination with Toxocara ova and the significant gaps in our knowledge with respect to the presence of Toxocara ova in water.


## 1.0 Epidemiology of the Disease and Pathogen

### 1.1 Global Burden of Disease

The zoonotic roundworms Toxocara canis and T. cati are not only present worldwide in their definitive hosts (canids and felids) where by dogs and cats (and related species) excrete the ova in their faeces; they also frequently occur in other paratenic, or accidental hosts, including humans. In those so-called paratenic hosts, the larvae do not develop into the adult stage, but rather migrate throughout the somatic tissue and persist as infectious L3 stage for extensive periods (Strube et al., 2013). Thus human faeces and sewage are not involved in the disease transmission.

Toxocariasis is considered to be one of the most widespread public health and economically important zoonoses that humans can contract (Macpherson, 2013). Recent research indicates that toxocariasis is the most common human parasitic worm infection in the United States, affecting millions of Americans living in poverty (Hotez and Wilkins, 2009). However, our current understanding of the global impact and economic cost of human toxocariasis is poor because there is insufficient clinical awareness and no clear repository for the efficacy of clinical, laboratory and treatment interventions (Smith et al., 2009).

#### 1.1.1 Global distribution

Toxocara spp. have a worldwide distribution and are particularly prevalent in the tropics and sub-tropics, in less industrialised nations where dog treatment and population control is limited (Macpherson, 2013). Infection is also highly prevalent in many developing countries and its global importance may be greatly underestimated (Hotez and Wilkins, 2009). Worldwide seroepidemiological surveys show human toxocariasis to be among the most frequently occurring helminthiases (Fan et al., 2015a). In a study carried out in the United States, Won et al. (2008) found that seroprevalence was 13.9% and was higher in non-Hispanic blacks (21.2%) than non-Hispanic whites (12%) or Mexican Americans (10.7%). In developed countries, such as the United States, Japan, Canada, Germany, United Kingdom, Italy, France, and Russia, seroprevalence has been found to be highest in rural areas, ranging from 35% to 42%, falling to 15% to 20% in semirural zones and to 2% to 5% in urban areas (Fillaux and Magnaval, 2013; Magnaval et al., 2001). Higher seroprevalences have been reported from developing countries like Nigeria (30%), Brazil (36%), Swaziland (44.6%), Malaysia (58%) Indonesia (63.2%), Nepal (81%), Marshall Islands (86.8%), and La Reunion (93%) (Smith & Noordin, 2006; Liao et al., 2010; Rubinsky-Elefant et al., 2010; Fu et al., 2014). However, as previously mentioned, an accurate analysis of seroprevalences between different countries and studies is hindered by the different methodologies used to detect infections (Western Blot or ELISA), different cutoff titers, and the difficulties in linking infection, titers, and

symptomatic disease (Smith et al., 2009; Alderete et al., 2003).

### 1.1.2 Symptomatology

At present there are four distinct clinical entities associated with human toxocariasis – these are visceral larva migrans (VLM), ocular larva migrans (OT), covert toxocariasis (CT) and cerebral toxocariasis or neurotoxocariasis (NT) (Fan et al., 2015b). However, the relationship between specific symptoms and signs of these clinical entities is not always clear cut or well understood due to the non specific nature of most of the symptoms (Smith et al., 2009).

#### 1.1.2.1 Visceral larva migrans (VLM)

VLM was first described by Beaver and colleagues in 1952 when the presence of Toxocara larvae was detected in eosinophilic granulomata in liver biopsies taken from three children who underwent laparotomy. VLM therefore refers to the migration of Toxocara larvae through the somatic tissues and the consequent pathogenesis. The disease is characterized by persistent and eosinophilia, hepatomegaly, respiratory symptoms and anaemia. However, the role of Toxocara in asthma remains unclear with contradictory results. For example, asthma and recurrent bronchitis was significantly associated with Toxocara seropositivity in young Dutch children of elementary school age (Buijs et al., 1997) but such an association was not detected in children aged between 2 and 15 years of age in the USA (Sharghi et al., 2001). However, more recently Walsh (2011) showed a significant association between diminished lung function and previous infection with Toxocara spp. in adults aged between 17 and 65 years old in the USA.

Cutaneous manifestations of toxocariasis have been reported including rash, urticaria and hypodermic nodules (Ehrhard and Kernbaum, 1979), however case reports predominate and a systematic population-based approach is lacking (Smith et al., 2009). A 2008 review conducted by Gavignet et al. concluded that the most commonly encountered skin manifestations associated with toxocariasis are chronic pruritus or prurigo, different forms of eczema, and chronic urticaria.

#### 1.1.2.2 Ocular toxocariasis (OT)

In 1950, Wilder discovered granulomata containing nematode larvae within the eyes of children that had been enucleated due to suspected retinoblastoma. Subsequently, what are now known to be third-stage larvae of Toxocara, were described by Nichols (1956) within the observed granulomata. These observations led to the description of ocular toxocariasis (OT).

OT is described as a relatively rare disease primarily observed in children (Taylor, 2006). OT is generally characterized by unilateral vision impairement, strabismus and leukocoria, although the clinical presentation may vary depending upon the site of larval involvement and the immune response of the host (Dinning et al., 1988). Blindness in one or both eyes is rarely observed (Taylor, 2001). However, a recent web-based survey conducted by the Centres for Disease Control (CDC, 2011) reported the most common symptom among those surveyed (68 patients diagnosed with OT) was vision loss (83%) with 68% of patients exhibiting permanent vision loss. Population-based estimates of the prevalence for OT are lacking (holl). A study of 121,156 schoolchildren carried out in Ireland (Good et al., 2004) recorded a prevalence of 6.6 cases per 100,000 persons (increasing to 9.7 cases per 100,000 persons when both definite and strongly suspected cases were included).

#### 1.1.2.3 Covert toxocariasis (CT)

Covert toxocariasis has been shown to be a cause of recurrent abdominal pain in childhood and is considered more common than other clinical forms of toxocariasis (Nathwani et al., 1992). It describes patients in whom positive Toxocara serology is associated with a number of systemic and localised symptoms and signs (notably abdominal pain), but not VLM or OT. CT was initially described by Bass et al. (1983, 1987) in the USA and Taylor et al. (1987) in Ireland. Glickman et al. (1987) also describe a similar syndrome in France, but named it ‘common toxocariasis’.

Covert toxocariasis was characterised by a moderate Toxocara elisa titre of >1:50, a normal or mildly elevated blood eosinophil count and multiple minor symptoms (such as abdominal pain, headache and/or cough) (Bass et al., 1983;1987; Taylor et al., 1987). In addition, Glickman et al. (1987) described weakness, pruritis, rash, difficulty in breathing and abdominal pain as the main symptoms. A quarter of patients have no eosinophilia and although symptoms regress after treatment, they may persist for months or years (Nathwani et al., 1992).

#### 1.1.2.4 Cerebral toxocariasis or neurotoxocariasis (NT)

Cerebral or neurotoxocariasis occurs in a paratenic host when the aberrant migration of larvae results in the organisms arresting in the brain or spinal cord. NT in humans was first described by Beautyman and Woolf in 1951 when an autopsy study of a child who died of poliomyelitis was carried out, in whom an Ascaris larva was found in the left thalamus. In 1997, Magnaval et. al. conducted a case-control study finding that T. canis larval invasion of the brain rarely induces recognizable neurological signs, possible due to repeated low dose infection. In the last 30 years, however, an increasing number of clinical NT cases due to larval invasion of the brain or spinal cord have been recorded due to improved methods of diagnosis. Many clinical symptoms have been described and include cerebral vasculitis, myelitis, eosinophilic meningoencephalitis, meningitis, encephalitis, seizures and cognitive deficits (Holland and Hamilton, 2013; Caldera et al., 2013; Finsterer and Auer, 2007). The number of cases of NT will tend to be underestimated due to nonspecific clinical signs when compared with VLM, as well as due to a lack of availability of appropriate testing,

thus leading to possible underdiagnosis (Holland and Hamilton, 2013; Hotez and Wilkins, 2009).

## 1.2 Taxonomic Classification of the Agent

Recently, MacPherson (2013) described at least 14 species of ascarid with zoonotic potential ranging from the ubiquitious T. canis (Holland and Smith, 2006) to the cryptic T. pteropodis (Prociv, 1989) and the emerging and highly pathogenic Baylisascaris spp (Graeff-Teixeira, Morassutti and Kazacos, 2016). However, despite zoonotic potential, the importance of many of these species to human health is likely to be negligible. What is quite clear is the central importance of T. canis due to the widespread distribution of the domestic dog. However, because it is not possible to distinguish Toxocara species serologically (Poulsen et al., 2015), we still do not know the relative importance of T. cati to human toxocariasis (Fisher, 2003). The nematode Toxascaris leonina is also a zoonotic ascarid parasite of the dog and cat (Miyazaki, 1991). However, the role of T. leonina in human disease remains unknown particularly given our current inability to distinguish Toxocara spp. serologically (Holland, 2017).

### 1.2.1 Taxonomy

Toxocara spp. are parasitic nematodes belonging to the Phylum Nematoda, Order Ascaridia, Superfamily Ascaridoidea, Family Ascarididae, Subfamily Toxocarinae and Genus Toxocara. The more prevalent species within the genus are T. canis, T. cati and T. vitulorum. Among a total of 21 species within the Toxocara genus, two are of significant public health concern, namely, T. canis and T. cati, for which dogs and cats, respectively, are the definitive hosts (Fan et al., 2015b).

### 1.2.2 Physical description of the agent

With regards to T. canis and T. cati, the eggs appear pitted on the surface. T. canis eggs measure 75 – 90 µm in diameter and are spherical whereas T. cati eggs measure 65 – 70 µm in diameter and have an oblong shape. The third stage T. canis larvae that hatch from the eggs (Brunaska et al., 1995) have an average length of 404 microns and an average width of 18 - 20 microns (Nichols, 1956). T. cati larvae that hatch from eggs have similar average lengths but are slightly thinner with an average width of 16 - 17 microns (Nichols, 1956). Adults have complete digestive systems and three lips with dentigerous ridges and occur in the intestine of the definitive host. O'Lorcain, (1994a) found that male worms had a mean length of 70mm and 48mm for T. canis and T. cati respectively. In the same study, egg-bearing females were found to have a mean length of 127mm (T. canis) and 68mm (T. cati). Immature (non-egg-bearing) females had a mean length of 58mm and 40mm for T. canis and T. cati respectively.

### 1.2.3 Tissue Tropism/Cellular receptors/Latency

In the definitive host (eg. the dogs and cats) , eggs are ingested, hatch in the small intestine and larvae penetrate the gut wall and enter the circulatory system. They reach the liver about 24 hours post infection via portal circulation through venous capillaries (Webster, 1958). About twelve hours later, larvae continue migration to the heart where the lung is reached via the pulmonary artery (Strube et al. 2013). From here, larvae may penetrate the alveoli wall leading to migration to the pharynx through bronchioles and trachea (Strube et al. 2013). After coughing and swallowing, larvae begin to develop into adult worms in the intestine, which occurs about 7–15 days post tracheal migration (Sprent, 1958). Eggs are then excreted in faeces into the environment and undergo embryonation which may take as little as three weeks or up to several months depending on the environmental and climatic conditions.

In the human paratenic host, the infective embryonated ova are ingested and hatch 2-4 hours later (Strube et al., 2013). Commonly, larvae hatch after consumption, penetrate the intestinal wall and during the so-called hepato-pulmonary phase migrate via the circulatory system to the liver and then to the lungs. From there, they continue migration into the systemic circulation (Strube et al., 2013), and can travel through tissue and the circulatory systems to the eye (OT), the liver/lung (VLM/CT) or the brain/spinal cord (NT). Here they enter an arrested stage of development. Migration routes as well as predilection sites depend on the host species, however nearly all organs may be affected with varying degrees of larval burdens.

## 1.3 Transmission

Adult worms of Toxocara spp. are found in the intestine of a wide range of domestic and feral definitive hosts. T. canis infects domestic dogs (O'Lorcain, 1994a), foxes (Roddie et al., 2008), wolves (Segovia et al., 2001) and coyotes (Wapenaar et al., 2013) whereas T. cati infects domestic and wild felids (Fisher, 2003). In contrast T. leonina infects both dogs and cats (Miyazaki, 1991). T. malaysiensis has been described as an ascarid of cats in Malaysia and China (Zhu et al., 1998; Gibbons et al., 2001; Li et al., 2006) and more recently from Vietnam (Le et al., 2016).

Both dogs and cats can become infected by ingesting infective eggs. In dogs, hatched larvae enter the bloodstream and travel via the liver to the lungs (Overgaauw, 1997). Larvae can then migrate up the trachea, where they are swallowed and then return to the small intestine to develop into adult worms. Where somatic migration occurs, larvae do not develop into adult worms but can remain in an arrested state within the tissues for long periods of time. This arrested state may change if the dog is a female and becomes pregnant; larvae can re-activate and migrate across the placenta thereby infecting the offspring in utero or alternatively larvae migrate to the mammary glands of the bitch and infect puppies during lactation (Overgaauw, 1997). However, lactational transmission is much less common than prenatal transmission (Burke and Roberson, 1985) but increases if the bitch is infected during mid-pregnancy or lactation (Burke and Roberson, 1985). In contrast, in cats transmammary transmission of T. cati does occur if cats are infected during lactation but there is no evidence of

transplacental transmission (Coati et al., 2004). Tracheal migration and the consequent development of patent infections in the intestine are more common in young dogs but multiple studies have demonstrated that adult dogs infected with low doses of infective eggs can also develop patent infections in the intestine emphasising their importance as reservoirs of infection (Dubey, 1978; Maizels and Meghji, 1984; Fahrion et al., 2008).

It has been suggested that the ingestion of third-stage larvae via predation may be a more important route of transmission for cats. Until recently, no data existed on the species identity of the larvae found in feral paratenic hosts. This was considered a significant gap in our knowledge (Holland, 2017). However, recently Krüchen et al. (2017) sampled 257 small rodents from Berlin, Germany and detected T. canis, T. cati and Parascaris DNA in the brains or skeletal muscle of 3.1%, 1.6% and 0.4% animals respectively. In contrast, serology by means of ELISA revealed a prevalence of 14.2% for T. canis.

More recently, it has been suggested that direct contact with contaminated dog or cat hair maybe another potentially important source of infection to humans (Wolfe and Wright, 2003; Roddie et al., 2008; Overgaauw et al., 2009). However, recent epidemiological evidence from a range of geographical locations and differing dog populations suggests that contact with well-cared-for dogs poses a low risk of infection (Keegan and Holland, 2010; evidence reviewed in Holland, 2017).

Fecund adult worms shed eggs in their faeces that can then contaminate the environment and under appropriate conditions of temperature and moisture, embryonate and hence become potentially infective (Traversa et al., 2014). Humans may become infected with Toxocara spp. through the ingestion of eggs directly from soil or indirectly via contaminated hands, food items for example unwashed, contaminated fruit and vegetables (Kłapeć and Borecka, 2012) or utensils (Glickman and Schantz, 1981).

Toxocara eggs can infect a wide range of paratenic hosts including small mammals, birds, earthworms and humans (Holland and Hamilton, 2006). Toxocara larvae do not develop to adulthood in such hosts but remain as third-stage larvae in their tissues (Brunaska et al., 1995; Strube et al., 2013). Paratenic hosts can act as food items for both definitive hosts (dogs and cats) and humans. Transmission via the consumption of raw or undercooked meat including chicken and liver has been implicated in human infection (Nagakura et al., 1989; Yoshikawa et al., 2008; Noh et al., 2012).

Therefore, in summary there are four key epidemiological reservoirs of Toxocara (Overgaauw and Van Knapen, 2013) – the presence of adult worms in the intestine of domestic and feral definitive hosts (dogs, cats and foxes), the presence of eggs in the environment, the presence of larvae in the tissues of paratenic hosts and somatic larvae in the tissues of definitive hosts (particularly in dogs – see Coati et al., 2004). With respect to the focus of this chapter, it is clear that the presence of adult worms in the intestine of feral and domestic definitive hosts and their ability to shed large numbers of potentially infective eggs into the environment and possibly water sources are the two key epidemiological reservoirs.

### 1.4 Population and Individual Control Measures

The European Scientific Council for Companion Animal Parasites (ESCCAP) recommends routine de-helminthisation of domestic pets to prevent dissemination of infective ova in the environment (ESCCAP, 2010). Lifelong control of worms, cleaning up of pet faeces, leash laws and faeces cleanup laws are also recommended. It is also recommended to fence playgrounds and sandpits to prevent entry of cats and dogs. Advised treatment protocols with anti-helminthics are as follows: Puppies should be treated from two weeks of age and every two weeks thereafter until two weeks after weaning; Kittens should be treated from three weeks of age and every two weeks thereafter until two weeks after weaning; Nursing bitches and queens should be treated concurrently with the first treatment of their offspring as they are known to develop patent infections at this time; Adults cats and dogs should be treated at least four times per year but ideally monthly treament would be best. If treatment is not performed, faecal examinations for the presence of helminths are recommended either monthly or every three months.

There is no recommended prophylactic treatment for humans. Despommier (2003) remarked that more effective single-dose treatment regimens with safer drugs for pediatric patients could help limit the time of illness, provided that adequate medical infrastructure is already in place. However, Wisniewska-Ligier et al. (2012) described long term persistence of certain symptoms among children with toxocariasis, even after several rounds of treatment. ESCCAP guidelines (2010) also recommend minimising exposure of children to potentially infected environments and grooming dogs to minimise coat contamination by worm eggs. Education of staff, pet owners and the community is also highlighted with co-operation between medical and veterinary professions recommended to achieve this. In humans, hand washing and washing of fruit and vegetables is an important hygiene measure for minimisation of risk (Klapec and Borecka, 2012) and thorough cooking of meat is also advised (Nagakura et al, 1989).

Despommier (2003) also stated that what is needed in terms of future control programs is the development of radical new approaches, such as effective molecular or DNA-based vaccines that offer the possibility of lifelong protection. The author hypothesised that oral baits laced with vaccine would be ideal for dealing with feral dog and cat populations, an approach similar to already existing protocols for the large-scale control of rabies in feral and wild animal populations. The ability to kill all Toxocara ova in contaminated soils is seen by most epidemiologists as a virtually impossible task, but if such a strategy could be found and safely implemented, extensive areas of previously contaminated land could be rendered Toxocara-free (Despommier, 2003).

1.4.1 Vaccines

There is no available vaccine for Toxocara spp. and there is none currently under development. Barriga (1988) suggested that complete resistance would require the prior control of the immunosuppression induced by the parasite as T. canis infections inhibit the production of homologous protective immunity and antibody responses to heterologous antigens. The author then stated that an anti-T. canis vaccine to eliminate the parasite in dogs would be feasible. Furthermore, Hrčková (2006) speculated that the strategy for Toxocara vaccine development could be focused on identification of natural antigens that are presented to the host's immune system during acute natural or experimental infection.

The gold standard treatment for human toxocariasis is currently benzimidazole administration, in conjunction with corticosteroids in the acute inflammatory phase of VLM and OT, but there have been no studies to investigate whether the two together are beneficial (Magnaval and Glickman, 2006). Surgical removal of granulomas is also a treatment option in certain cases of OT (De Souza and Nakashima, 1995).

1.4.2 Hygiene measures

Both the Center for Disease Control (CDC) in the United States and ESCCAP advise picking up and disposing of animal faeces (but not in recycleable waste or compost) (CDC, 2013; ESCCAP, 2010). Good personal hygiene, hand washing and washing of food are also advised. The CDC (2013) recommends washing hands with soap and water after playing with any animals, after any activites outdoors and before handling food. Education of children in the area of personal hygiene is also recommended as is not allowing them to play in areas soiled with animal faeces and teaching them that eating dirt or soil is dangerous. It is advised to clean the domestic pet's living area at least once per week, burying or disposing of pet faeces in waste disposal and washing hands after handling pet wastes (CDC, 2013).

## 2.0 Environmental Occurrence and Persistence

Definitive hosts such as dogs, cats and foxes release Toxocara spp. eggs in their faeces. Once released, eggs require a period of time under appropriate environmental conditions to develop to infectivity (Mizgajska-Wiktor and Uga, 2006). Once deposition has occurred, embryonation of Toxocara eggs is mainly influenced by both temperature and humidity (O'Lorcain, 1995; Stromberg, 1997; Gamboa, 2005). Variation in soil type has also been identified as a factor that influences the survival and infectivity of Toxocara eggs (Nunes et al., 1994). This section aims to highlight the existing data on environmental contamination with Toxocara ova and the significant gaps in our knowledge with respect to the presence of Toxocara ova in water.

### 2.1 Detection Methods

Quantification of environmental contamination with helminths poses major technical challenges: methods are needed that are both sensitive enough to estimate low—but epidemiologically relevant—concentrations of soil-transmitted helminths (STH), and cost-effective enough to be deployed in low resource settings where the impact of STH is highest (Collender et al., 2015). In order to quantify STH density in a sample, ova, larvae or their genetic material must be isolated from the environmental matrix and then concentrated. Recovery of STH from soils, biosolids, and water samples typically involves five key processes: homogenization, chemical dissociation from the matrix, filtration, sedimentation, and flotation (Collender et al., 2015).

Toxocara spp. recovery from soils varies between soil types (sand, silt clay or some combination of two or more), method (passive or centrifugal flotation), detergent (Tween 40, Tween 80, NaOH) and flotation solutions (zinc sulphate, magnesium sulphate, sodium nitrate and sodium chloride) (Collender et al., 2015).

An assessment of several different flotation fluids found a saturated solution of magnesium sulphate plus 5% potassium iodide to be the most efficient in detecting ova in soil. Zinc sulphate was found to perform poorly by comparison (Quinn et. al., 1980).

Some Toxocara researchers pre-process samples by filtering them through coarse 4 mm2 sieves (O'Lorcain, 1994b; Quinn et al, 1980) or fine 150 µm sieves (Zibaei et al., 2010; Fajutag and Paller, 2013; Horiuchi, Paller and Uga, 2013; Shrestha et al., 2007), prior to homogenization and other processing in order to remove twigs, rocks, and larger soil particles. One group found that by air-drying a 200g soil sample overnight at room temperature, then sieving it down to 2g of powdery sand using the 150 µm sieve, up to a maximum of 40% efficient recovery may be achieved, meaning this method may provide greater throughput for soil samples at the expense of some sensitivity (Uga et al., 1997). A group in Kansas, USA reported that mechanical blending to disrupt large particles provides better results than sieving (Dada and Lindquist, 1979). A recent study conducted in Germany (Kleine et al., 2016) evaluated a non-hazardous recovery method using Tween80 and sodium chloride and found that the evaluated method for egg recovery from soil showed above-average recovery rates.

The effectiveness of current methods to detect parasite eggs in wastewater and sewage sludge is 30 to 75% (Gaspard and Schwartzbrod, 1995). Zdybel et al., (2016) remarked that the composition of sludge makes it similar to soil with its high humus content making it difficult to investigate using traditional parasitological methods and that another feature of sewage sludge is the content of chemical substances applied during the hygienisation and dehydration processes. The 'own method' described by Zdybel et al. (2016) examined sludge dehydrated by polyelectrolytes, taking into consideration that polyelectrolytes used for dehydration of sewage

significantly limit the effectiveness of parasitological examination of sewage sludges. The method described by Zdybel et al. (2016) was adapted to such types of substances. It was found to be several times more sensitive than other routinely used procedures and as a validated quantitative method it can be applied to official parasitological examination of sewage sludges providing reliable results (Zdybel et al., 2016).

In 2003, Gaspard and Schwartzbrod described a sampling strategy to accurately quantify the level of helminth contamination in sludge, accounting for both Nematodes (Ascaris, Trichuris, Capillaria and Toxocara spp.) and Cestodes (Hymenolepsis and Taenia spp.). They sampled from 2 wastewater plants in France using a modified zinc sulphate solution for flotation and concluded that the recommended sampling frequency can be limited to every 3 to 6 months.

The most current review of techniques for detecting and quantifying the total number of viable soil-transmitted helminth eggs in environmental samples was conducted by Amoah et al. (2017) and detailed conventional methods, nucleic acid based techniques, emerging techniques and future prospects with regard to environmental samples. Conventional techniques such as sedimentation, flotation and microscopy are traditionally used for soil, wastewater and sludge/biosolid analysis but can be laborious and time consuming. Nucleic acid based techniques allow for more sensitive, specific and rapid detection of pathogens. They can also enable species identification such as the duplex quantitative real-time PCR assay for the detection and discrimination of the eggs of T. canis and T. cati in soil and fecal samples (Durant et al., 2012). Emerging techniques include a parasite identification system using image analysis software to identify and enumerate parasite eggs (including T. canis) in wastewater with reported sensitivities of 80-100% and a specificity of 99% (Jimenez et al. (2016). A study carried out by Dabrowska et al. (2014) demonstrated that a LIVE/DEAD bacterial viability kit could be useful in the future for assessing the viabiility of Toxocara eggs occurring in sludge. The authors investigated the possibility of distinguishing between live and dead eggs in water by means of an assessment of the appropriate amount of dyeing mixture needed to distinguish between live and dead eggs. The investigation subsequently demonstrated that not only could different genera of Ascarids (Toxocara, Trichuris and Ascaris) be identified but that their viability could also be ascertained.

Collender at el. (2015) concluded that methods for sampling and recovering STH require substantial advances to provide reliable measurements for STH control. The use of automated image identification and developments in molecular genetic assays offer considerable promise for improving quantification and viability assessment. Furthermore, subsequent validation and comparison of techniques is required in order to identify the most cost-effective and efficient technique for uniform detection and quantification of STH eggs in environmental samples (Amoah et al., 2017).

## 2.2 Data on Occurrence in the Environment

Humans are known to become infected with Toxocara spp. following ingestion of embryonated eggs. Toxocara ova are not embryonated when passed in the faeces of dogs (Glickman, 1993) therefore, contamination is likely to come primarily from the environment (Morgan et al., 2013). Fisher (2003) also states the importance of cats as environmental contaminators with T. cati, although infection in cats and prevalence of T. cati in the environment has been studied in much lesser detail to date.

The literature on environmental contamination with Toxocara spp. ova is almost entirely confined to examination of soil (Pietrobelli et al., 2014). The presence of potentially infective or infective eggs of Toxocara spp. in the environment is one of the key routes of transmission to humans. Infected definitive hosts such as dogs, cats and foxes release their faeces, and the helminth eggs within them, into the environment. However, our understanding of the relative importance of the different host sources is incomplete (Morgan et al., 2013; Nijsse et al., 2015).

### 2.2.1 In sewage and sludge

Eggs of Toxocara could end up in sewage and primarily in sludge via disposal of cat and dog faeces to the sewer or via leaks in the system which allows run-off carrying soil and the eggs into the sewer. Sewage sludge (or biosolids) is the residue collected after treatment of the contents of urban drainage systems consisting of human waste, industrial effluents, discharges from animal or vegetable processing and run-off from land and roads (DEFRA, 2017). Sludge is rich in nitrogen, phosphorus and organic matter and is, therefore, a good source of nutritional requirements for crops, making it an attractive agricultural fertilizer. However, sludge may also contain pathogenic bacteria, viruses and parasites and improper management and use could pose a risk to human health as well as animal and plant health.

Zdybel et al. (2015) assessed 17 municipal mechanical-biological wastewater treatment plants in Poland for the presence of parasite eggs at different stages of processing. Eggs of Toxocara spp. were detected in almost all stages of processing, including raw wastewater, preliminary sludge, excess sludge, fermented sludge and dehydrated sludge. Furthermore, the eggs detected were viable and were present with mean egg counts ranging from 2.67 eggs per 1 g dry matter in preliminary sludge to 0.25 eggs per 1 g dry matter in dehydrated sludge (final stage of processing).

In a study of a similar number of wastewater treatment plants in France, Schwartzbrod and Banas (2003) investigated the level of parasite contamination of liquid sludge. Fresh sludge and discharged sludge (destined for agricultural use) were subjected to filtration, flotation and two rounds of phase separation before eggs were counted by microscopy. Out of a total of 194 samples analysed, 153 (79%) were contaminated with helminth eggs, 135 of which contained viable nematode eggs and 77% were identified as Toxocara spp.

In the 1980s, Reimers et al. (USEPA, 1981; 1986) conducted two large studies investigating the types and densities of parasites in sewage sludge in treatment plants in both the Southern (USEPA, 1981) and Northern (USEPA, 1986) United States. In the Southern study, sludge samples were collected from 27 municipal wastewater treatment plants over a year-long period, incorporating the four different seasons (spring, summer, autumn and winter). Toxocara spp. was among the four most common parasites found, with viable eggs being detected at least once from every plant sampled across all seasons.

2.2.2 In Surface Water and Drinking Water

The potential role of drinking water and the recreational use of water in transmission of Toxocara spp. may also be significant but has yet to be studied extensively (Beér et. al., 1999). Public beaches adjacent to municipal drinking water supplies just outside Moscow in Russia, were implicated as sources of Toxocara contamination (Beér et. al., 1999). The authors speculated that by allowing dogs and cats free access to these recreational areas, there is an increased likelihood that infective Toxocara spp. ova would enter the water of the lake. Bathers frequently and inadvertently drink water while wading and swimming, allowing for the possibility of ingesting infective eggs. Patients diagnosed with toxocariasis in the municipality confirmed bathing and involuntary swallowing of water in urban unflowing reservoirs.

2.2.3 In Groundwater

Pedley et al. (2006) have stated that, in general, the transmission of helminths in groundwater is unlikely, although not impossible, due to the size of the ova. There is no currently available data concerning Toxocara spp. in groundwaters.

2.2.4 In Seawater and Shellfish

There is no available data concerning Toxocara spp. in seawater and shellfish.

### 2.3 Persistence

Toxocara spp. eggs are extremely resistant to physical and chemical agents, and in temperate climates can survive well over winter, for 6 to 12 months (Fan et al., 2015a). Azam et al. (2012) investigated the influence of temperature on the development of T. canis larvae under laboratory conditions and found that in water at 15, 20, 25, 30 and 35°C and at room temperature (22°C ± 1°C) T. canis eggs could develop to an embryonated stage at all tested temperatures with development occurring more quickly at higher temperatures. Survivability of eggs under moist, cool conditions may be up to 2 to 4 years or more (Azam et al., 2012). Several factors can influence the development, survival and availability of eggs to potential hosts, including light, temperature, pH, humidity, the substrate and vegetation cover, and physical dispersal of eggs by definitive hosts or through the actions of birds, rainfall, flies, beetles, earthworms, and slugs (Fan et al., 2015a).

## 3.0 Reductions by Sanitation Management

Sanitation is the hygienic means of promoting health through prevention of human contact with the hazards of wastes, in particular via the treatment and proper disposal of human excrement, often mixed into wastewater. In the framework of agricultural wastewater reuse, the WHO has defined a parasitological quality for sewage with less than one nematode egg per litre (Gaspard and Schwartzbrod, 2003). Municipal facilities such as wastewater treatment plants must practice careful sanitation management to protect the health of communities.

### 3.1 Wastewater Treatment

Helminth ova size, density and shell all influence the egg's behaviour during processing and due to these properties it is very difficult to inactivate them so they are usually removed by sedimentation or filtration processes (Jimenez, 2007).

In 2007, Jimenez published data detailing the current known information concerning helminth ova removal during wastewater treatment. The author drew attention to the 1989 and 2006 WHO water reuse guidelines (WHO, 1989; 2006) where helminth ova are considered to be one of the main target pollutants to be removed from wastewater before reuse in agriculture and aquaculture. Wastewater treatment processes are described and reviewed as to which are useful in removing helminth ova from wastwater. Six types of processes are detailed: waste stabilisation ponds, reservoirs, constructed wetlands, coagulation-flocculation, rapid filtration and the upflow anaerobic sludge blanket (UASB).

To remove helminth ova in waste stabilisation ponds where sedimentation is the most important factor, a minimum retention time of 5 to 20 days is required. Most ova are retained in the first anaerobic pond (Jimenez, 2007). In reservoirs and dams, helminth ova can be removed from wastewaters if retention times of >20 days are implemented (Jimenez, 2007). In order to remove 100% of helminth ova in constructed wetlands, it would be necessary to coule the wetlands with a horizontal flow gravel bed, with most of the removal being achieved in a 25m length (Rivera et al., 1995; Stott et al., 1999). Coagulation-flocculation processes such as chemical enhanced primary treatment (CEPT) and advanced primary treatment (APT) are both efficient at removing helminth ova while retaining organic matter, nitrogen and phosphorus in the water (Jimenez, 2007). Rapid filtration (>2m/h) removes 90 to 99% of helminth ova and this removal can be increased by 2 to 4 $\log_{10}$ if coagulants are added (USEPA, 1992). The UASB ia an anaerobic biological reactor that can remove helminth ova through sedimentation and filtration in the sludge bed (Jimenez, 2007). The author emphasises the pressing need for more research in the field due to little information about helminth ova behaviour in wastewater.

3.1.1 Composting of faecal wastes

Composting of waste is an aerobic process to aid decomposition of solid wastes. The process involves decomposition of organic waste into humus known as compost which can then be re-used, sometimes in an agricultural setting. As humans are a paratenic host for Toxocara spp., the life cycle of the parasite is arrested. The eggs do not pass through the gastrointestinal tract of humans and therefore composting of human fecal wastes would not be an appropriate action for reducing contamination of the environment with Toxocara spp ova.

Composting during sludge treatment was investigated by Gantzer et al. (2001). The group monitored the bacterial and parasitological contamination to determine the impact of various sludge treatments on the two types of pathogens. Nematode eggs belonging to the following genera were identified: Ascaris (34.8%), Trichuris (37.7%), Toxocara (13.7%) and Capillaria (13.8%) (grouped together as 'nematode' eggs). Compost consisted of 1/3 sludge, 1/3 sawdust and aerated pile with a retention time of 21 days of ventilation and 7 days of suction at a temperature of 50 to 55°C. The initial total concentration of nematode eggs in the compost was 6.2+/-6.7 eggs per 10g dry matter (DM) with 1.5+/-2.0 eggs per 10g DM being classed as viable. On exit, the total had decreased to 1+/-1.2 total eggs/10g DM and <1 viable eggs/10g DM. Even though the initial count was low, it does seem that composting is a successful method in reducing viable egg load in sludge.

In contrast in 2007, Nemiroff and Patterson published a study analysing an experimental large-scale dog waste composting programme set up in 2004 in Quebec, Canada. The results were positive in that dog waste composting was found to be a feasible and highly functional method of managing large amounts of dog waste in an environmentally-friendly way but no testing for helminth eggs was performed so it is unknown whether this composting would reduce environmental contamination by Toxocara spp. eggs from definitive hosts such as dogs.

3.1.2 Wastewater treatment facilities

The relatively high number of eggs recovered from sludge is indicative of the high level of environmental contamination with Toxocara spp. ova. Once passed in the faeces of cats and dogs, Toxocara spp. eggs can remain viable in the soil for several years (Mizgajska-Wiktor and Uga, 2006) allowing for the possibility of the eggs being washed into public drains/sewers and therefore into wastewater treatment plants. If eggs survive wastewater treatment and retain viability, there is a possibility that infectious eggs could be applied to crops in sludge fertilizer and therefore pose a potential risk to human health.

Use of sludge fertiliser is under strict regulatory control specifically to monitor levels of potentially toxic elements that may build up on the soil.

Due to the potential pathogenic hazard, sludge applications on food crops are usually timed to coincide with planting, grazing or harvesting operations (DEFRA, 2017). Sludge must not be applied to growing fruit and vegetable crops, unless it is applied at least 10 months before harvest. The WHO recommends a limit of 3 to 8 helminth ova per gram of total solids for sludge which is destined for agricultural use (Jimenez, 2007). This is greater than the limit set by the United States Environmental Protection Agency of 1 helminth ova per gram of total solids (Jimenez, 2007).

In the previously discussed study conducted in France by Gantzer et al. (2001), which aimed to determine the impact of various sludge treatments on different species of bacteria and parasites, certain processes were found to perform better than others in terms of reducing viable nematode eggs in sludge. No different resistances (Ascaris, Trichuris, Toxocara and Capillaria) to the various treatment were observed and the authors therefore evaluated the global behaviour of all nematode eggs. Several treatment processes were analysed. These included - four biological treatments (mesophilic stabilisation, anaerobic mesophilic digestion, aerobic thermophilic digestion and composting), three chemical treatments (liming with slaked lime (26% and 62%) and quick lime; One heat treatment: drying at 108°C; Two storage treatments from dehydrated sludge treated by anaerobic digestion and sludge treated with 62% slaked lime). The total concentration of nematode eggs in the sludge was not greatly affected by treatment or storage, and was in the range of <1 to 66 eggs/10g DM. However, the situation was different for mean viable egg counts which ranged from <1 to 30 eggs/10g DM. In France, sludge is considered to be sanitised when the threshold value for parasitic nematode eggs is <3 viable nematode eggs/10g DM.. In this study, it was found that four treatments - aerobic thermophilic digestion, composting, heat treatment and the storage of sludge treated with 62% lime – were successful and that no viable eggs were detected post treatment. Anaerobic mesophilic digestion, mesophilic stabilisation, treatment with slaked (26%) or unslaked (25%) lime, and the storage of dehydrated sludge did not produce sanitised sludge, demonstrating that the mesophilic processes studied were inefficient at eliminating viable nematode eggs. The long-term storage (240 days) of dehydrated sludge and the treatment of sludge with 62% slaked lime gave values at the limit of acceptability (3 eggs/10g DM and 3.2 +/-0.8 eggs/10g DM respectively). However, contrasting with these results, quicklime treatment (25%) resulted in high levels of viable nematode eggs in the treated sludge (10.5 +/-12.3 eggs/10g DM). The authors speculated that the poor performance of treatment with quicklime, despite the pH reaching 12.4, may be due to high initial concentrations of viable nematode eggs (23.2 +/- 14.6 eggs/10g DM) and/or poor liming conditions.

A study in Poland by Zdybel et al. (2015) determined the degree of municipal wastewater contamination with intestinal parasite eggs of the genera Ascaris, Toxocara, and Trichuris at individual stages of treatment. The authors found that the largest number of viable eggs of Ascaris spp., Toxocara spp., and Trichuris spp. were found in sewage sludge collected from the primary settling tank. A slightly lower number of the eggs were found in the samples of excess sludge, which indicates that the

sedimentation process in the primary settling tank is not sufficiently long to effectively separate parasite eggs from the treated sewage. The number of eggs of Ascaris spp. and Toxocara spp. in the fermented sludge was nearly 3 times lower than that in the raw sludge. The effectiveness of hygienisation of dehydrated sewage sludge by means of quicklime was confirmed in two wastewater treatment plants, with respect to Ascaris spp. eggs, in three plants with respect to Toxocara spp. eggs, and in one plant with respect to Trichuris spp. eggs. The mean reductions of numbers of eggs were 0.46 $\log_{10}$, 0.41 $\log_{10}$, and >2 $\log_{10}$, respectively. In one wastewater treatment plant, a reduction in the number of viable eggs of Ascaris and Trichuris species was also noted as a result of composting sludge by 0.82 $\log_{10}$ and 0.60 $\log_{10}$, respectively.

The effects of mesothermic anaerobic or aerobic sludge digestion on the survivability and viability of eggs of a number of nematodes and cestodes including T. canis revealed that neither method of digestion evaluated destroyed the Toxocara eggs and the viability of the eggs was unaffected (Black et. al., 1982).

In the Reimers et al. studies (USEPA, 1981; 1986) parasite concentrations varied depending on whether the sample was collected pre-treatment (primary and secondary sludge) or post-treatment (aerobic or anaerobic digestion, filtration, lagoons or drying beds) with numbers of Toxocara spp. eggs per kg dry weight varying from 700 to 1200, respectively. It is noteworthy that egg viability in pre-treatment samples was 88% and only decreased to 52% in post-treatment samples (a decrease of 0.19 log10 reduction). In the Northern United States study, sludge samples, from all stages of processing, were collected from 48 municipal wastewater treatment plants ranging in processing size from <1 million gallons per day to >50 million gallons per day (USEPA, 1986). In total, 20 different parasite species eggs or cysts were recorded and Toxocara spp. was among the four most commonly found, similar to results from the Southern United States study (USEPA, 1981). Parasite concentrations varied depending on the stage of processing the sludge sample was collected, with highest geometric means being detected in samples taken during digestion (1200) compared to undigested (880) and post-digestion (330) samples. Egg viability decreased during processing from 78% in undigested samples to 74% during digestion and to 50% post-digestion (a decrease of 0.14 $\log_{10}$ reduction overall).

In a small study of 3 municipal sewage treatment plants in Czechoslovakia, Horák (1992) investigated the presence of parasites in five types of sludge sample – after anaerobic digestion at 25 to 26°C, after aerobic digestion, after activation in ditches, after anaerobic digestion at 33 to 35°C and after anaerobic digestion at 38 to 42°C. Sample sizes were small but Toxocara spp. was detected in all five types of sludge, with numbers ranging from 12 to 47 eggs per 100g dried sludge, the highest being detected in samples collected after aerobic digestion. The author did not specify if the eggs were viable.

In a similarly small study in Chicago, Arther et al. (1981) investigated the presence of parasite ova in freshly digested sludge directly from anaerobic digesters and lagooned sludge from retention basins. Fifteen separate aliquots per sample were dried to determine the dry weight of sludge and then examined for parasite eggs. Toxocara spp. eggs were the second most abundant, following Ascaris spp., in lagoon sludge, with a mean of 173 eggs per 100 g dry sludge. Sixty four Toxocara spp. eggs in total were recovered from fresh anaerobically digested sludge and of these, 34 (53%) were viable.

3.1.3 Tertiary treatment

This data has been included in the above section.

## 3.2 Disinfection

Disinfection is considered the primary mechanism for the inactivation/destruction of pathogenic organisms to prevent the spread of waterborne diseases to downstream users and the environment. It is important that wastewater be adequately treated prior to disinfection for any disinfectant to be effective (Wastewater Technology Fact Sheet Ozone Disinfection, EPA). Disinfection is accomplished both by filtering out harmful micro-organisms and also by adding disinfectant chemicals. Water is disinfected to kill any pathogens which may pass through filters and to provide a residual dose of disinfectant to kill or inactivate potentially harmful micro-organisms in storage and distribution systems. Possible pathogens include viruses, bacteria and parasites. Following the introduction of any chemical disinfecting agent, water is typically held in temporary storage - a contact tank or clear well to allow the process of disinfection to complete.

Aycicek et al. (2001) discovered iodine disinfectant solutions to be effective against embryonated eggs of T. canis. Iodine disinfectants produced a statistically significant difference in larvicidal ability when compared with a range of other other common disinfectants (glutaraldehyde, benzalkonium chloride, sodium hypochloride, potassium permanganate, ethyl alcohol, potassium hydroxide, phenol solutions). In the in vitro experiment, T. canis eggs were treated with disinfectant solutions at different time intervals, and larval motility was observed. Microscopic examinations revealed that T. canis eggs treated in 2.5 to 10% iodine solutions were completely non-motile at different times post-treatment respectively, whereas the eggs treated with the all other disinfectants were still motile after 24 hours. In the in vivo experiment, 1000 embryonated eggs treated with disinfectants were inoculated into mice orally. Mouse brain tissue was then examined for larval presence on day 7 post-inoculation. No T. canis larvae were observed in mice inoculated with eggs treated with any of the iodine solutions but larvae were observed in the other study groups inoculated with eggs treated with the other disinfectants.

Treatment with 70% ethanol inhibited embryogenesis of T. canis (Verocai et. al., 2010). In contrast, sodium hypochlorite caused some morphological damage to ova but they were still able to develop into larva and remained infective for up to 2 weeks. Larvae derived from eggs treated with benzalconium chloride and formaldehyde-

based disinfectant remained infective and were able to migrate when administered to mice. The authors also found that even long-term exposure to routinely used disinfectants had no effect on T. canis eggs. The disinfectants tested were products that are routinely used in veterinary hospitals, kennels, animal shelters and laboratories (benzalconium chloride, 70% ethanol, 2 to 2.5% sodium hypochlorite solution, 7.99% formaldehyde-based disinfectant). Tap water was used as a negative control.

Shalaby et al., 2011 carried out an experiment testing hydrogen peroxide plus dihroxy benzol at a 3% solution for use as a disinfection agent against T. canis eggs. The solution was found to have an ovicidal effect on unembryonated eggs after a 24 hour exposure with 99.73% (2.6 $\log_{10}$) inhibitory activity acheived. However, the solution was not found to have any effect on embryonated eggs, with no morphological changes apparent and no cessation of motility of larvae.

3.2.1 Chlorine and ozone

Ooi et al. (1997) found that despite treatment with ozone, unembryonated T. canis eggs were found to develop into viable second stage larvae. Viability of second stage larvae was also not affected by treatment with ozone as assessed by oral inoculation into mice and recovery of larvae from liver, lungs and digestive tract 48 hours post-infection. Jimenez-Cisneros (2007) states that helminth ova cannot be inactivated with chlorine, UV light or ozone (in the latter case at least not with economical doses because >36 mg ozone per litre are needed with one hour contact time). Burge and Borgsteede (1987) found that chlorine had no effect on Ascaris suum. Based upon this observation, it can be argued, due to their similar properties of resistance, that the same would be true for Toxocara spp.

3.2.2 Irradiation and UV disinfection

No data was found by the authors concerning irradiation or UV disinfection of Toxocara spp. However, Shamma and Al-Adawi (2002) treated Ascaris lumbricoides ova in sewage sludge water with gamma-radiation of doses between 1.5 and 8 kGy. Major morphological changes were noted and eight weeks post treatment no larvae were detected within the shells. A later study investigated treatment of A. lumbricoides ova from filtered wastewater and secondary effluent with UV radiation (Al-Awadi et al., 2006) that accelerated the development of larvae with increasing UV dose.

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# Toxocara-infecties bij mens en dier

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Toxocara-infecties (toxocariasis) van hond en kat vormen een potentieel risico voor de mens wanneer deze infectieuze toxocara-eitjes opneemt uit de omgeving. De larven uit deze eitjes komen vrij in de darm, migreren door het lichaam om zich uiteindelijk in te kapselen. Ze kunnen diverse ziektebeelden veroorzaken zoals het viscerale migranssyndroom, oculaire larva migrans of neurotoxocariasis. Mede door onbekendheid met toxocariasis bij artsen, wordt de infectie door de Centers of Disease Control and Prevention (CDC) in de Verenigde Staten gerekend tot 1 van de 5 ‘most neglected parasitic infections’.

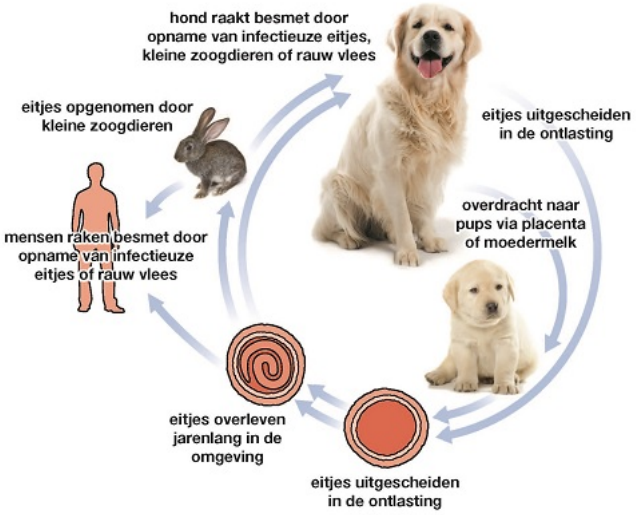
## Toxocara-infectie bij hond en kat

Bij een patente infectie bevinden zich eiproducerende spoelwormen in de dunne darm van hond, vos (*Toxocara canis*) of kat (*Tococara cati*). In recent onderzoek was de prevalentie bij deze dieren in Nederland respectievelijk 4,6%, 61% en 7%. (1) De wormen scheiden dagelijks vele duizenden eitjes uit die in de omgeving terechtkomen via de ontlasting van de dieren. In gemiddeld 3 weken tot enkele maanden komen de eitjes (i.e. de larve in het eitje) in een infectieus stadium. De eitjes zijn in de grond zeer resistent tegen omgevingsinvloeden en kunnen tot waarschijnlijk enkele jaren infectieus blijven. Als de eitjes weer opgenomen worden door dieren komen in de maag en dunne darm de larven uit, die via de bloedbaan, lymfe of de buikholte en de lever naar de longen migreren. Hier worden ze opgehoest en komen na doorslikken terug in de darmen waar ze uitgroeien tot volwassen wormen (Figuur 1).

Geleidelijk ontwikkelen jonge dieren immuniteit (leeftijdsresistentie) en gaan de larven na opname in het dierenlijf over in een ruststadium en komen niet meer in de darmen terecht. Bij een drachtige gastheer worden deze 'rustende' larven weer geactiveerd en besmetten de pups in de baarmoeder, en na de geboorte, pups en kittens via de moedermelk. De eerste spoelwormeieren worden door pups al vanaf 2 tot 3 weken oud en door kittens vanaf 7 weken oud uitgescheiden. Naast directe besmetting uit de omgeving kunnen ook verschillende soorten zoogdieren en vogels de infectie overbrengen, als zogenoemde transportgastheer.

Na opname van een besmet prooidier vindt geen migratie plaats in het lichaam, maar ontwikkelen de larven zich direct in de darm tot volwassen wormen en beschermt eventueel aanwezige leeftijdsresistentie niet tegen ei-uitscheiding. (2)

Pups en kittens kunnen ernstig ziek worden door larven en volwassen wormen in de darm. Bij volwassen dieren worden zelden klachten gezien. Het is voornamelijk vanuit het oogpunt van de volksgezondheid dat infecties met volwassen wormen voorkomen/bestreden dienen te worden.




**Figuur 1.** *Levenscyclus Toxocara canis (bron: ESCCAP)*

***De rol van de kat***

In de literatuur wordt, op basis van epidemiologische aannames, regelmatig alleen de spoelworm van de hond genoemd als risico voor de mens en die van de kat stelselmatig genegeerd. Bij routine serologisch onderzoek is het niet mogelijk om onderscheid te maken tussen beide *Toxocara sp*. In experimenteel onderzoek, met kleine aantallen monsters, is dit wel gelukt met de Ouchterlony-techniek. Daarbij was *Toxocara cati* de oorzaak van de helft van de positieve infecties. De verwachting is dat het risico groter is dat de mens besmet raakt met *Toxocara cati* dan met *Toxocara canis*. Dit is omdat de kat zijn ontlasting meestal in de directe leefomgeving van de mens begraaft. Een andere aanwijzing hiervoor is de vergelijkbare toxocaraserologie bij mensen in islamitische landen, waar veel meer katten dan honden worden gehouden. (3,4)

***Preventie van besmetting van hond en kat***

De European Scientific Counsel Companion Animal Parasites (ESCCAP) adviseert honden- en katteneigenaren hun dieren te laten te ontwormen aan de hand van de uitslag van fecesonderzoek en factoren die van invloed zijn op besmetting en verspreiding, zoals buiten komen, rauw vleesvoeding krijgen of prooidieren eten. Wanneer het besmettingsrisico van het individuele dier niet duidelijk is vast te stellen, wordt geadviseerd om dit minimaal 4 keer per jaar te doen. (5,6) Slechts een beperkt aantal eigenaren (24%) volgt dit advies op. Honden dragen voor 39% bij aan de omgevingsbesmetting en katten (huis- en zwerfkatten) voor 46%. Nijsse rekende uit dat dit percentage voor de hond bij 4 keer per jaar ontwormen daalt naar 28%, en bij stelselmatig opruimen van de ontlasting zelfs naar 4%. Dit laatste effect is vergelijkbaar met maandelijkse ontworming. Het opruimen van hondenontlasting wordt in Nederland door gemiddeld 35% tot 40% van de eigenaren gedaan. (1,7)

Van katten, die geen gebruik maken van de kattenbak, is het opruimen van ontlasting niet zo eenvoudig. De kat zoekt een plek met los materiaal om de ontlasting te kunnen begraven. Meestal gebeurt dit in de (moes)tuin, bossages, de zandbak en kinderspeelplaatsen. Deze laatste hebben steeds vaker een ondergrond van los zand in plaats van rubber matten of kunstgras. Ongeveer de helft van de huiskatten gebruikt voornamelijk de kattenbak, de rest defeceert buiten (44%) of gebruikt beide mogelijkheden (8%). (1)

Onderzoek in Japan met nachtcamera's, gericht op 3 openbare zandbakken, wees uit dat hierin gedurende 5 maanden 961 katten- en 11 hondenfeces werden gedeponeerd en dat in dit 80% van de gevallen 's nachts gebeurt. Recent onderzoek in Nederland gaf aan dat in gemiddeld 20% van de onderzochte zandbakken en parken in Assen, Utrecht en Den Haag toxocara-eitjes werden gevonden. Van de 116 grondmonsters bleek 12,9% positief te zijn. Uit onderzoek in Polen bleek dat de besmetting van tuinen het grootst was met 6,4 eitjes per gram aarde, in vergelijking met andere plekken zoals parken, straten, strand en speelweiden. (8)

## Toxocarabesmetting van de mens

***Vanuit de omgeving***

Besmetting bij de mens kan optreden wanneer infectieuze spoelwormeitjes worden opgenomen uit de omgeving, zoals bij tuinieren, het spelen in zandbakken en het recreëren in openbare parken. Ook het eten

van ongewassen groenten en sommige fruitsoorten van eigen moestuin is een besmettingsroute. 2-10% van de kinderen tussen 1-6 jaar eet grond - *pica*, de zucht naar het consumeren van niet-eetbare dingen - waardoor zij een grotere kans hebben om besmet te raken. (12) Kinderen jonger dan 3 jaar blijken iedere 2-3 minuten hun handen of voorwerpen in hun mond te stoppen. Uit een ander onderzoek bij kinderen van 1-4 jaar op een kinderdagverblijf bleek dat de kinderen gemiddeld 40 mg zand per dag opaten. Eén kind at dagelijks zelfs gemiddeld 5 tot 8 gram zand. (8)

***Andere besmettingsroutes***

Sporadisch zijn ook andere besmettingsroutes naar de mens beschreven, zoals na het eten van onverhitte leverpâté (in Frankrijk) of van kuikenvlees (in Japan) dat besmet was met larven. Het binnenkrijgen van eitjes door direct contact met hond en kat, en dan met name via de vacht, is in diverse publicaties gesuggereerd. De kans daarop wordt echter uitermate klein geacht. Deze eitjes zijn vooral aanwezig nadat een hond bijvoorbeeld op de grond heeft liggen rollen en/of zijn vacht besmeurd is met feces van besmette dieren. De eitjes zullen onder invloed van zonlicht en lage relatieve vochtigheid snel afsterven. (7) Besmetting van een nog ongeboren kind via de placenta is niet aangetoond.

***Ziektebeeld bij de mens***

Na orale opname van infectieuze toxocara-eitjes komen onder invloed van het maagsap de larven vrij, passeren het darmslijmvlies en bereiken eerst de lever. Vervolgens maken ze via de bloedbaan, weefsels en lichaamsholten een trektocht door het lichaam en gaan in organen en weefsels, vooral zenuwweefsel en spieren, over in een ruststadium. *Toxocara canis*-larven hebben een voorkeur voor de cerebra, die van *Toxocara cati* voor het cerebellum. (9) Larven migreren niet voortdurend, maar kennen regelmatig periodes van rust. Ze veroorzaken immuungemedieerde ontstekingsreacties die zijn gericht op de veranderende oppervlakte-antigenen van de larven.

Als het gaat om een klein aantal larven, zullen de meeste mensen geen klachten hebben. Bij grotere aantallen kunnen niet-specifieke griepachtige klachten optreden, zoals algemene malaise, koorts, buikpijn, leververgroting en hoesten. Dit wordt viscerale larva migrans (VLM) genoemd.

Larven die zich verplaatsen in de longen kunnen astmatische aandoeningen veroorzaken die geassocieerd worden met het hypereosinofiel syndroom. Onderzoek door het RIVM met muismodellen liet zien dat een enkele infectie met *T. canis*-eitjes tot maandenlange hyperreactiviteit en ontsteking van de luchtwegen kan leiden. (10) Ook is een relatie aangetoond tussen infectie met *Toxocara* en het tot uiting komen van allergische aandoeningen zoals astma en eczeem bij kinderen. (10,11) In 1983 werd al geadviseerd om toxocariasis op te nemen in de differentieel diagnose bij kinderen met persisterende en onbegrepen eosinofilie in combinatie met terugkerende buikklachten. Na een massale toxocariasis kunnen ook ernstige complicaties optreden zoals myocarditis, levensbedreigende pneumonie en nefritis. De bloeduitslag toont persisterende eosinofilie (vooral bij kinderen), leukocytose en verhoogde leverenzymen zoals gamma-glutamyltransferase. (10,12)

Wanneer een toxocaralarve in het oog terechtkomt en afsterft kan een choroidaal granuloom ontstaan met een secundaire granulomateuze retinale laesie en een endoftalmitisachtig beeld. Dit kan leiden tot vermindering of volledig verlies van het gezichtsvermogen, oculaire larva migrans. (12,13)

Voordat in de jaren 50 van de vorige eeuw duidelijk werd dat deze parasiet een rol speelt bij een choroidaal granuloom, werd bij patiënten regelmatig een oog verwijderd omdat men dacht dat het om een retinoblastoom ging. Het CDC meldt dat in de Verenigde Staten jaarlijks minstens 70 patiënten zijn met eenzijdige blindheid als gevolg van toxocariasis van het oog. (14)

Granulomen kunnen ook in de lever aanwezig zijn en zichtbaar worden met een CT-scan, MRI of echografie. Met echografie zijn dan meerdere, kleine, ovale hypogene gebiedjes te zien die van metastasen zijn te onderscheiden omdat ze niet rond en uniform van grootte zijn en een onduidelijke begrenzing vertonen. Bij herhaald onderzoek kunnen er meer gebiedjes te zien zijn of veranderd zijn van positie als gevolg van de migratie van larven. (15) De larven worden na hun migratie als granulomen ingekapseld in de weefsels en zonder herinfectie zullen eventueel aanwezige klinische klachten verdwijnen. De larven kunnen bij de mens niet uitgroeien tot volwassen wormen, maar wel tot 10 jaar in het lichaam overleven. (12)

Kinderen vanaf de kleuterleeftijd kunnen last hebben van covert toxocariasis, een niet-specifiek vaag ziektebeeld in combinatie met verhoogde toxocaratiters. Zij hebben dan buikpijn (Idiopathic Abdominal Pain of Childhood), hoofdpijn en hoesten. (12,16)

Ten slotte is de laatste jaren toxocariasis van het zenuwstelsel, neurotoxocariasis, beschreven waarbij patiënten onder andere epileptische aanvallen hebben en eosinofiele meningo-encefalitis. Dit wordt vaak niet herkend omdat het gepaard gaat met niet-specifieke gedragsafwijkingen. (16)

De afgelopen jaren laten verschillende onderzoeken zien dat kinderen met toxocariasis verminderde cognitieve vaardigheden hebben dan kinderen die niet positief testen op *Toxocara*. Ook worden mentale retardatie, ontwikkelingsstoornissen en pica hieraan gerelateerd. (17,18,19) Het is bij deze studies lastig om een oorzaak-gevolgrelatie aan te tonen, maar bij met *Toxocara* geïnfecteerde muizen werd ook een verminderd leervermogen en geheugen aangetoond. (20)

***Diagnostiek en sero-epidemiologie***

De diagnostiek is gebaseerd op het klinisch beeld, bloedbeeld (o.a. eosinofilie) en serologisch onderzoek van serum of oogvocht met gebruikmaking van het toxocara-excretie-secretie(ES)- antigeen in een ELISA-test. Om kruisreacties te voorkomen met bijvoorbeeld Ascaris, kan de diagnose bevestigd worden met Western Blot, een biochemische techniek om specifieke eiwitten aan te tonen. (10) Het probleem is dat er geen duidelijke criteria zijn opgesteld voor toxocariasis en geen gestandaardiseerde serodiagnostische testcriteria beschikbaar zijn. Daardoor zijn resultaten in publicaties niet altijd goed vergelijkbaar.

De seroprevalentie varieert sterk tussen de verschillende Europese landen en in de wereld. Van 2,5% in Duitsland en Denemarken, 5% in Zweden, 6,6% in Italië, 14% in de USA, 16% in Nederland tot ruim 90% op sommige Caraïbische eilanden. (10,21) In een onderzoek onder ruim 2100 Ierse schoolkinderen tussen de 4 en 19 jaar, werd een hoge toxocaraprevalentie van 31% gevonden. Jongens waren significant vaker dan meisjes serologisch positief, evenals kinderen van het platteland versus de stad. Er werd een relatie gevonden met grond eten en het hebben van een huisdier. De hoogste titers werden gevonden bij kinderen van 7 jaar. (22) In Ierland werd onderzoek gedaan naar oculaire larva migrans onder 120.000 schoolkinderen van dezelfde leeftijd. Daarbij werd een prevalentie van 6,6 per 100.000 kinderen vastgesteld. Wanneer de sterk verdachte gevallen daarbij worden opgeteld, steeg deze naar 9,7. Ook hier werd een relatie vastgesteld met grond eten en daarnaast epilepsie. (23) In weer ander onderzoek naar oculaire larva migrans bleek dat 40% van de patiënten grond had gegeten. (12)

Toxocariasis is niet meldingsplichtig krachtens de Infectieziektenwet en de ziekte wordt in waarschijnlijk door onbekendheid in combinatie met het vage klachtenbeeld regelmatig gemist. (18)

***Behandeling***

Bij de meeste patiënten met toxocariasis (met name covert toxocariasis en asymptomatische toxocariasis) worden geen medicijnen voorgeschreven. Afhankelijk van de ernst van de symptomen wordt als eerste keuze albendazol geadviseerd, eventueel gecombineerd met corticosteroïden. (24) Daarbij bestaat het risico van ernstige overgevoeligheidsreacties veroorzaakt door (massaal) stervende larven. Dit is vooral een probleem bij de oculaire vorm. De dosering van het anthelminticum wordt daarom geleidelijk gedurende een aantal dagen verhoogd onder gelijktijdige toediening van corticosteroïden. Bij behandelingen met mebendazole worden minder bijwerkingen gerapporteerd. (16) Bij oculaire larva migrans vindt therapie plaats in overleg met oogarts en parasitoloog. De behandeling kan bestaan uit corticosteroïden en retinovitreale chirurgie, eventueel gecombineerd met albendazol. (24)

## Groter risico bij kinderen

Kinderen, voornamelijk in de leeftijd van 1 tot 3 jaar, blijken vaker geïnfecteerd te zijn met *Toxocara* en ernstigere klachten te ontwikkelen dan volwassenen. Hun immuniteit is zich nog aan het ontwikkelen en deze groep wordt in het algemeen als gevoeliger wordt beschouwd. Het is ook bekend dat kinderen vaker in contact komen met (besmette) grond en de vingers veelvuldiger in de mond steken. Ook gebruikelijke handhygiëne wordt niet altijd goed betracht.

De laatste jaren vindt het fenomeen ‘modderdag’ voor kleine kinderen vlak voor de zomer plaats. In 2017 hebben al ruim 70.000 kinderen hieraan deelgenomen. Volgens de organisator IVN (Instituut voor Natuurbeschermingseducatie) “ontdekken kinderen zo wat modder is, hoe je er mee kunt spelen en wat de verbinding met de aarde voor hen betekent”. Dergelijke initiatieven geven in het kader van de hier genoemde infectierisico’s echter ernstig te denken en GGD’en zouden dit moeten afraden.

Dat toxocariasis bij kinderen regelmatig kan worden gediagnosticeerd wanneer het in de differentiële diagnose wordt opgenomen, blijkt uit een onderzoek in een Pools ziekenhuis. (25) Hier werd gedurende 6 jaar tijd bij 103 kinderen van gemiddeld 7 jaar de diagnose toxocariasis gesteld. Bij alle kinderen werd, volgens de auteurs ter preventie van het ontstaan van de oculaire vorm, een behandeling met anthelmintica ingesteld zonder corticosteroïden. Dit komt overigens niet overeen met de therapierichtlijn in Nederland (24); hier is het advies om niet alle patiënten standaard te behandelen maar om corticisteroïden per patiënt te overwegen.

In het Poolse onderzoek werden aan 46 kinderen zelfs 3 behandelingen gegeven. Bij de oculaire vorm werden meerdere soorten anthelmintica gebruikt. De buikpijn, hoofdpijn, vergrote lymfeklieren en verlies van eetlust

namen geleidelijk af. Na een eerste behandeling werd bij 18% van de patiënten een negatieve titer gevonden, terwijl die bij 37% juist verder was gestegen. Dat laatste kan verklaard worden door het uiteenvallen van afgedode larven. Hoofdpijn bleek bij veel kinderen op lange termijn te persisteren, zelfs wanneer de toxocaratiters negatief waren. In het artikel wordt niet vermeld, maar wel tijdens de presentatie van het onderzoek tijdens het Toxocara2012 congres (6), dat (vooral hoofdpijn) klachten na iedere behandeling toenamen en titers en leverenzymen weer stegen. Dit was voor de onderzoekers reden om een tweede behandeling te starten, waarna, als het resultaat hetzelfde was, sommige kinderen een derde keer behandeld werden. Het nalaten van een behandeling om de larven rustig te laten inkapselen, eventueel in combinatie met corticosteroïden, is vaak een betere keuze.

## Preventie

Toxocarabesmetting van de mens is te voorkomen door verschillende maatregelen.

- Allereerst dient omgevingsbesmetting voorkomen te worden. Het consequent opruimen en correct afvoeren van de ontlasting van honden en katten (restafval) is hier van groot belang.
- Door het regelmatig ontwormen van hond en kat, vooral pups en kittens en het niet toelaten van honden op kinderspeelplaatsen en -weides wordt ook voorkomen dat omgevingscontaminatie plaats vindt.
- Kinderzandbakken in de tuin dienen te worden afgedekt indien er geen gebruik van wordt gemaakt. Zandbakken in openbare ruimtes, zoals op speelplaatsen en bij scholen, zouden uit volksgezondheidsoogpunt niet toegestaan mogen worden wanneer zij niet worden afgedekt.
- Het verbieden van vrijlopende katten, zoals onlangs voorgesteld in een Nederlandse gemeente, zal ongetwijfeld een effectieve preventieve maatregel zijn. Daarnaast zijn echter vele honderdduizenden verwilderde zwerfkatten in ons land aanwezig die de omgeving besmetten.
- Door het dragen van handschoenen bij tuinieren en het goed wassen van groente en fruit, wordt de kans op infectie via grond tegengegaan.
- Het betrachten van goede hygiëne, met name bij kinderen, zoals handen wassen voor het eten of voor het koken, na het buitenspelen, tuinieren en diercontacten. En als de nagels bij kinderen kortgeknipt zijn kan er minder aarde/grond achter blijven zitten.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# 5-07 CATS AS RESERVOIR OF ZOONOTIC HELMINTHS

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Domestic cats are descended from African wild cats (*Felis silvestris lybica*) since approximately 8000 BC, in the Middle East (Driscoll, 2007). In ancient Egypt cats were already cult animals and nowadays they are considered as the most popular pet in the world. Cats are found at almost every place where people live and ownership has been proven to be important for the well-being of owners (Serpell, 1991). This relationship is known as the human-animal bond and is responsible for socialization, mental health, and even physical well-being of the human (Beck and Meyers, 1996; Paul *et al.*, 2010).

## → ONE HEALTH

Controlling zoonotic agents in animals is an effective strategy for controlling them in people. This is part of the One Health concept, defined as the collaborative work of multiple disciplines to help attain optimal health of people, animals, and our environment (Paul *et al.*, 2010). There is a central role for the control of the spread of infectious diseases.

Infections of man caused by cat helminths are widely published. The presence of similar parasites in both man and cats does not necessarily mean a zoonotic infection. The definition of a zoonosis is that a natural transmission from cats to man should occur (direct or indirect, via the environment or vectors). The recognition that animals can be vector of disease is more apparent in veterinary medicine than in human medicine. This may be the result of a physician's training that is limited to a single species and often misunderstood or underappreciated (zoonotic) parasitic diseases. These can therefore often be mismanaged or underdiagnosed (Paul *et al.*, 2010).

## → CATS & ZOONOSES

Direct contact with cats is very common in many parts of the world and parasitic zoonosis can directly be transmitted from cats to humans (Overgaauw *et al.*, 2009). The more indirect fecal-oral route, however, is considered as more important for the transmission of soil or water-transmitted helminth infections after ingestion of infective parasite eggs or larvae. Finally, eating raw or undercooked meat or fish may also be a risk factor for parasitic zoonoses from cats (Chen, 2012). This is applicable for free-roaming (wild) hunting cats that are allowed to feed on waste of wild animals, and in cases when owners are feeding bones, raw meat, and organ meat to their cat. There is an increasing trend of this feeding of Bones and Raw Food or Biologically Appropriate Raw Food (BARF) to cats. The goal is to introduce all-natural foods in order to replicate what the domestic cat's ancestors naturally eat in the wild. Followers believe that cats can achieve a better state of overall health than their commercially-fed counterparts. Free-roaming cat populations have been identified as a significant public health threat and are a source for several zoonoses and zoonotic parasites (Gerhold and Jessup, 2013).

The ubiquitous problem in urban areas of the world of stray cats emphasizes the need to diagnose, treat and prevent zoonoses including parasitic nematodes. In many developed countries, considered as free from serious infectious diseases in man, cats still harbor prevalent but mostly sub-clinical helminth infections.

## → RISK ANALYSIS

The relative risks for the human health by cats is for the majority of feline zoonoses largely unknown or studies carried out remain to be inconclusive. This is due to failure in examining both pet owners and their cats simultaneously and comparing isolates by genotyping, serotyping or other identification methods to prove infection or to demonstrate a common infection source.

Each risk analysis has a first step consisting of an overview of the local potential biological hazards, followed by hazard characterization including the prevalence in the reservoir (cats), virulence for the human, transmission routes, and survival of the parasite in the environment. These criteria are weighed, mostly based on expert's opinions.

The second step is assessment of the exposure to the infective stage of the parasite. Who is exposed to the potential hazard, for how long or how often. How much of the potential pathogen is needed to become a health risk? The exposure may directly be related to the behaviour of the owner in relation to their cat or the infected environment.

The third step is to calculate the impact of an infection based on the seriousness of the disease, the chance for complications, and the eventual economic consequences that may be expected (e.g. labour hours lost). Each of the parameters can be ranked in classes varying from negligible to most serious. The ranking is based on literature data, own observations (measurements) or expert's opinions. The final risk assessment can be achieved by multiplying the outcome of the hazard characterization, exposure assessment and impact. The result is a number that represents a ranking order of the potential health hazards. It has no absolute meaning. The prioritizing is based on multi-criteria analysis and the results give information of the public health impact of the parasites concerned. This will vary depending on the region that is involved. For the Netherlands, for example, the first five emerging zoonotic parasites that may be transmitted by cats are prioritized in order of importance as *Toxoplasma gondii*, *Echinococcus multilocularis*, *Giardia felis* (*G. duodenalis* Ass. F), *Toxocara cati*, and *Dirofilaria repens* (Havelaar *et al.*, 2010).

## → OWNER'S BEHAVIOUR WITH CATS

As cats are increasingly considered a member of the family, physical contact is very common. Cuddling, stroking, and playing with the animals are all normal behaviour of cat owners and even more the children of the family. It is part of enjoying pet animals, but a pet has become more often a substitute for childbearing and child care, sometimes leading to excessive pet care and intensive contacts (Chomel and Sun, 2011). During the diner of the owner, cats are often allowed to approach, begging for food, being stroked, or even allowed to join the dinner. Therefore it is necessary to wash hands after contact with animals and before a meal. The number of potential pathogens such as enterobacteriaceae (Westgarth *et al.*, 2008) and parasite eggs (Overgaauw *et al.*, 2009; Keegan and Holland, 2010) from the fur of animals, including cats, is easily detectable on hands. The pathogens can be washed off easily by water and household soap.

Allowing cats to sleep in the bedroom or even to sleep in the bed of the owner (30-62 %) is certainly contributing to transmission of zoonoses including parasites (Overgaauw *et al.*, 2009; Chomel and Sun, 2011). The increasing trend to feed raw meat to cats is described before and may also a risk to transfer (zoonotic) parasitic infections to cats.

Amongst soil transmitted diseases serious consideration must be given to toxoplasmosis and toxocarosis, because cats might act as active distributors of oocysts and eggs from the environment into the house. An important role of the veterinarian is to make owners aware of the potential risks and the need of personal and kitchen hygiene, without creating panic. Awareness and responsible pet ownership are the important issues to achieve a healthy relationship between owner and cat. Pet ownership means obligations to assure the welfare and health of the animal as well of the owner. This is called responsible pet ownership and includes among others that owners provide preventive (e.g., vaccinations, parasite control) and therapeutic health care for the life of pet(s) (JAVMA, 2012) to prevent transmission of pathogens to the human.

This chapter reviews the most relevant cat helminth zoonoses, which can be divided in nematode, cestode and trematode infections. Since the biology and epidemiology of the parasites will be discussed in other chapters, the information is more focused on the transmission routes to the human, the disease in man and the control measures. The used parasite nomenclature is following the standardized nomenclature of animal parasitic diseases (Kassai *et al.*, 1988).

## → FELINE NEMATODE ZOONOSES

In Table 1 an overview is presented of common feline nematode zoonoses. Several infections are very rare in the cat as well as in the human. The significant zoonoses will be discussed more into details.

TABLE 1 → Overview of feline zoonotic nematodes.

| ANIMAL INFECTION | PARASITE | INTERMEDIATE HOSTS | HUMAN INFECTION | DISTRIBUTION |
|---|---|---|---|---|
| Ancylostomosis | *Ancylostoma braziliense, A. ceylanicum* | None | Creeping skin eruptions | World-wide |
| Dirofilariosis | *Dirofilaria repens* | None | Subcutaneous or subconjunctival nodules | Europe, Asia, Africa |
| Gnathostomosis | *Gnathostoma spinigerum* | Freshwater fish, frogs, reptiles, birds, copepods (*Cyclops*) | Skin, CNS, eye, respiratory tract | Asia, Oceania |
| | *G. binucleatum* | | | The Americas |
| | *G. americanum* | | | South America |
| Thelaziosis | *Thelazia callipaeda, T. californiensis* | | Unilateral conjunctivitis | Europe, Asia, N. America |
| Toxocarosis | *Toxocara cati* | None | Visceral or ocular larva migrans | Worldwide |

## ↳ *Ancylostoma* spp.

Hookworms (Ancylostomatoidea) are, after the ascarids, the most commonly found nematodes in carnivores. The worms inhibit the small intestine of their hosts and show a dorsal bend in the anterior body that enables 'hooking' on to the intestinal mucosa, which explains their name. *Ancylostoma braziliense* is the cat and dog hookworm in Africa, southern Asia (Indonesia, Borneo, and Malaysia), tropical Australia, South and Central America, and the southern US (Traub *et al.*, 2007). *A. ceylanicum* is found in dogs, cats and wild Felidae in Asia, including Indonesia and Japan, and parts of South America and is known to use often successfully the human as definitive host. The feline hookworm *A. tubaeforme* is not capable to invade the human skin (Kalkofen, 1987).

### → ZOONOTIC INFECTION

Hookworms may cause cutaneous larva migrans (CLM) or 'creeping eruption' in man, which is caused by percutaneous infection of *A. braziliense* $L_3$ larvae from the environment (Bowman, 2011). The larvae are obtained from soil that is contaminated by infected cat feces. The infection is most common in children and in adults in areas with warm, moist climate who are sunbathing, playing or going frequently barefoot in moist, sandy soil areas contaminated with larval hookworms and therefore common in travellers returning home. Professionals at risk are construction workers, such as plumbers, electricians, and technicians working in the crawl space beneath a house and gardeners tending flowerbeds and vegetable gardens (Hendrix *et al.*, 1996). Clinical manifestations in human zoonotic hookworm infection involve the skin, blood, and intestine. Infectious larvae of *A. braziliense* will cause lesions after penetration the skin, usually via hair follicles. The larvae will not migrate to deeper skin areas but remain in the epidermis. The larvae can invade the skin directly or through damp clothing and cause only in humans the classical linear skin lesions or cutaneous larva migrans, also known as creeping eruption, dermal larval migrans, ground itch, plumber's itch and sandworms. One hour after infection papules and local itching and pain develop. The multiple serpiginous, elevated, reddened, linear, tunnel-like, pruritic skin eruptions appear within 1 to 4 days, lasting up to 3 months or more. Within weeks to months after the initial infection, the larvae die and will be reabsorbed by the host. After elimination of the larvae, scarring can be considerable. Tracheal migration of larvae is described with infiltrates appearing in chest X-rays a week or later after the rash commenced. Blood eosinophilia will develop and last for 4-6 weeks (Bowman, 2011).

*A. ceylanicum* appear to spend less time in the skin of the human host, and if they do cause lesions, they appear to produce lesions that are more vesicular or that cause disease of a markedly shorter duration. Infection with *A. ceylanicum* occurs mainly peroral and the parasite can complete its life cycle in humans causing abdominal symptoms. Under natural conditions the parasite causes only light intestinal infections with few eggs (Overgaauw and Van Knapen, 2000).

Diagnosis of hookworm infection rests on the history, with special attention for travellers returning from the tropics and sub-tropics, and on clinical recognition of the characteristic lesions. Symptoms commence between 1 and 29 days after returning home. Present serology is neither adequately sensitive nor specific.

A common misconception is that human infection is acquired from direct contact with cats. There is no increased risk of infection, because transmission is only by contact with the infective larvae. Wearing shoes in infected areas can achieve protection. Children's sandboxes should remain covered when not in use. If free roaming cats defecate in public areas, the feces should be removed as much as possible. Further measures are prohibition of dogs and cats on playgrounds and beaches and increasing the awareness among public health workers, veterinarians and pet owners (Bowman, 2011). Control of the patent infection in the cat involves routine fecal examination and treatment of the animals if necessary.

## ↳ *Gnathostoma* spp.

The genus *Gnathostoma* contains several species from which the *G. spinigerum* was believed to cause human gnathostomosis in endemic areas in Asia and Australia. Human infection with *G. hispidum*, *G. doloresi*, and *G. nipponicum* were found only in Japan. In the Americas, *G. binucleatum* is the only proven pathogenic *Gnathostoma* nematode in humans (Katchanov *et al.*, 2011).

Adult parasites are found in gastric nodules in the stomach wall of animals that consume raw fish. *G. spinigerum* is found in gastric nodules of wild (tigers, leopards, lions, minks, opossums, otters, and raccoons) and domestic Canidae and Felidae that shed the eggs in their feces. The dog and cat are considered the most significant or principal reservoirs of the worm in many countries. A prevalence of 11 % *S. spinigerum* infection was found in Indian stray cats (Borthakur, 2011). The eggs hatch in water and pass through a copepod intermediate host and freshwater fish, aquatic snakes, amphibians, reptiles, small mammals, and fowl that act as paratenic hosts. Ingesting paratenic host infects the cat where the larvae migrate through the abdominal cavity to the stomach wall where they produce eggs (Quinn, 1997). Most cats are asymptomatic. Rupturing of cysts may result in acute abdominal signs.

### → ZOONOTIC INFECTION

Gnathostomosis is a foodborne zoonotic helminthic infection caused by the third-stage larvae of *Gnathostoma* spp. nematodes. Human infection follows ingestion of raw or undercooked fish, however other animals such as frogs, snakes, chickens, snails, and pigs can serve as intermediate hosts. Thus, ingestion of undercooked fish is not the only means of acquiring infection. Man is accidental host and the parasite fails to reach maturity in the human host. Larvae and young adults migrate primarily to the skin, subcutaneous tissue, and mucous membrane causing inflammation and mechanical damage. The clinical manifestation is developing within 3 to 4 weeks to several months and is characterized by localized, intermittent, migratory swellings of 5 mm in the skin and subcutaneous tissues, often in association with localized pain, pruritus, and erythema lasting 1-2 weeks. This is called the larval migratory swelling syndrome (Waikagul *et al.*, 2007). The general health condition of the patient is usually normal but there may be several attacks in one year and these signs can persist for eight to twelve years. The worm can also migrate to deeper tissues and other organs including respiratory tract, muscles, genitourinary system, and the eye (Otranto and Eberhard, 2011). The most severe manifestation involves infection of the central nervous system (neurognathostomosis). Almost all neurognathostomosis cases are reported from Thailand and have also been reported in returned travelers in Europe (Katchanov *et al.*, 2011). Significant mortality can occur (Schmutzhard *et al.*, 1988). In heavy infections, transient gastrointestinal symptoms such as nausea, vomiting, abdominal cramps and diarrhea, may occur within 24 hours that may be confused with appendicitis. Malaise, chest discomfort, coughs, myalgia, weakness, and cutaneous migratory swellings may follow this (Migasena *et al.*, 1991).

Human infection can be diagnosed by identification of recovered worms or by a history of dietary preferences, residence or travel in an endemic area, intermittent migratory swellings, and eosinophilia (values exceeding often 50 % of the total white blood count). Using an ELISA-test, antibodies against *G. spinigerum* adult antigen can be detected in sera. Spontaneous recovery of the parasite is not very common. It is very difficult to remove the worm from CNS or cutaneous lesions, because it is moving fast and the edema and inflammation is indicating its previous location. Anthelminitic treatment is effective (Waikagul *et al.*, 2007).

The prevention of the infection in man can be achieved by not eating raw or half-done preparations in any form of food prepared from animal flesh or other organs of the second intermediate or paratenic hosts. Handling raw animal organs, flesh, or carcasses of these animals should only be done wearing hand-gloves. Untreated potential contaminated freshwater should not be drunk. Health education of the public on the above principles of personal prevention of the infection is required. Diagnosis of gnathostomosis in the cat is made by fecal examination to find the eggs. Anthelmintics should be given to kill the parasite and prevention consists of preventing the ingestion of intermediate or paratenic hosts. In endemic areas with lots of feral cats it will be difficult to control the parasite in the population.

## ↳ *Thelazia* spp.

Thelaziosis is an infection of the conjunctiva of domestic and wild dogs and cats. *Thelazia californiensis* is found in western USA, and *T. callipaeda* in Asia and Europe (Otranto *et al.*, 2011). The disease is also called eyeworm. Various muscid non-biting flies serve as vector and pick up larvae by lapping eye secretions of infected animals. In the eye of the final host the larvae mature within 2 to 6 weeks. Adults can survive in the eye for many years and larvae can overwinter in the dipteran pupae (Weinmann, 1977). Infections are commonly asymptomatic or with mild lacrimation, conjunctivitis and photophobia. Heavy infestations may cause keratitis and cornea lesions.

### ↳ ZOONOTIC INFECTION

Humans, mainly young children and babies, are infected when infected flies are feeding around their eye. Human thelaziosis may cause mild to severe clinical signs such as (unilateral) pain, lacrimation, epiphora, conjunctivitis, keratitis and/or corneal ulcers, and the sensation of a foreign body in the eye (Weinmann, 1977; Otranto and Eberhard, 2011). The symptoms resolve in most cases immediately after removal of the worm(s). The diagnosis can be made on the clinical signs and by finding adult parasites in the conjunctival sac or microscopic identification of larvae in the lacrimal secretions. The parasite can be removed with (local) anesthesia using fine forceps or moistened cotton applicators. Control can be achieved by preventing contacts with flies and by the use of insect repellents in endemic areas.

## ↳ *Toxocara cati*

*Toxocara cati*, a roundworm of the cat, is probably the most common gastrointestinal helminth of domestic felids worldwide. Infection is reported in domestic and wild Felidae were adult *T. cati* generally inhibit the small intestine of the cat. The reported infection rates in domestic cat populations vary from 8 % to 76 % (Overgaauw and Van Knapen, 2013). Outdoor cats, especially when hunting, are considered as an important contributor to environmental contamination. These animals show not only a higher prevalence of *Toxocara* infection, but there is also a strong association found between the presence of both *Taenia taeniaformis* and *T. cati* infection, which proves the ingestion of paratenic hosts. After ingestion of an infected paratenic host, the larvae develop directly in the intestine. Another indication that this route of infection is the most important for the cat is the absence of lung lesions in cats with a patent *Toxocara* infection. Cats catch and eat more prey animals than dogs and this may be the explanation why higher infection rates are found in cats than in dogs. This has been proven in studies in the USA where *Toxocara* spp. prevalence of pet cats, fed with commercial food, of 5,5 – 10,6 % found, compared with shelter cats, that often survived by catching prey animals, with a prevalence of 22,2 – 41,4 % (Adolf *et al.*, 2010, Little, 2013). In a recent European survey the average *Toxocara* prevalence in cats was 19,9 %. From all infested animals 32 % were cats that did not hunt and 68 % were hunting (Beugnet *et al.*, 2014).

The role of *T. cati* as a zoonotic parasite is not always clearly recognized. Despite the fact that differentiation between *T. canis* and *T. cati* infections is still not feasible in serological surveys, the majority of reported human cases of toxocarosis have been associated with *T. canis* based on epidemiological considerations (Fisher, 2003). The large number of common antigenic fractions shared between *T. canis* and *T. cati* and the similarity in the mode of infection are indications that there is no difference in the zoonotic risk (Cardillo *et al.*, 2009). In Islamic countries, where dogs are avoided for religious reasons, while cats are favored as pets, the seroprevalence of human toxocarosis can be considerable (Smith and Noordin, 2006). Thus, the potential role of *T. cati* in human toxocarosis should not be ignored or underestimated.

### ↳ ZOONOTIC INFECTION

Man acts as an unnatural host in which *Toxocara* larvae will not develop but migrate and survive for a long time. The mode of transmission to humans is by oral ingestion of infective *Toxocara* eggs from contaminated soil (sapro-zoonosis), from unwashed hands or consumption of raw vegetables. Some infections may occur from ingestion of larvae in under-cooked organ and muscle tissue of infected paratenic hosts such as chickens, cattle and sheep. Vertical transplacental transmission in pregnant women as a result of activated somatic larvae, similar to situation in the dog, does not occur (Overgaauw and Van Knapen, 2000). Direct contact with the fur of infected cats is not considered as a potential risk because embryonation of *Toxocara* ova to the stage of infectivity requires a minimum of 3 weeks. Although a low percentage of eggs in fur have been observed to be embryonated, they are mostly not viable. In addition, *Toxocara* spp. eggs are very adhesive and difficult to remove from cat hair, which lessens the likelihood of them, being accidentally swallowed by a human. *T. cati* infections are therefore more likely to be a hazard for people exposed to contaminated environments (Overgaauw *et al.*, 2009; Keegan and Holland, 2010). Toxocarosis is a public health problem. The seroprevalence of *Toxocara* spp. antibodies varies between countries. In Sri-Lanka children aged 1-12 years showed a seroprevalence of 43 % (Iddawela *et al.*, 2003). Approximately 13.9 % of the U.S. population has antibodies to *Toxocara* spp. (CDC), and in the Netherlands the prevalence was found to be 4 – 15 % in individuals under 30 years of age and 30 % in adults older than 45 years, with an average figure of 19 % (De Melker *et al.*, 1995). Continuous re-infection is probably the cause of a raising prevalence in adults.

FIGURE 1 → Infective larvated *Toxocara* egg.

A number of different syndromes have been attributed to *Toxocara* spp. infection: visceral larva migrans (VLM), ocular larva migrans (OLM), and covert toxocarosis (CT). In addition, associations with neurological and atopic symptoms have also been described. The diagnosis of human toxocarosis is based on clinical presentation, laboratory tests and sero-diagnostic techniques. In computer tomography, magnetic resonance imaging (MRI), and sonography hepatic lesions may be seen as multiple, ill-defined, oval lesions. MRI can be used in patients with neurological syndromes to detect granulomas located cortically or subcortically.

Children are more frequently clinically affected than adults, and severe VLM is mainly seen in children from 1 to 3 years of age. A worldwide review of VLM and OLM cases revealed that more than half of the patients were younger than three years, and only one fifth were adults (Ehrhard and Kernbaum, 1979; Gawor *et al.*, 2008).

The higher infection risk in children can be explained by their behaviour, since young children play more often in, and thus have closer contact with, potentially contaminated soil in yards and sandpits, and often put their fingers into their mouths, sometimes even eating dirt. In a well-conducted study of Irish school children, the prevalence of consultant-diagnosed eye disease was 6.6 cases per 100,000 children (Good *et al.*, 2004). Relationships between *Toxocara* spp. antibody seroprevalence and the incidence of chronic airway disorder (asthma), elevation of serum IgE concentration, the presence of allergen-specific IgE and eosinophilia, have been found (Pinelli *et al.*, 2008). Occurrence of asthma or recurrent bronchitis and hospitalization due to asthma were significantly related to seroprevalence, while eczema tended to be more frequent in children aged 4 – 12 years in the Netherlands. It was concluded that a previous infection with *Toxocara* spp. leads to exacerbation of allergic phenomena in children, who are predisposed to asthma (Buijs *et al.*, 1997). Chronic 'idiopathic' urticaria, chronic pruritus, and miscellaneous eczemas in adults and children have also been associated with toxocarosis (Gavignet *et al.*, 2008). Nevertheless, a systematic population-based study on skin pathology and *Toxocara* spp. seropositivity is lacking (Smith *et al.*, 2009).

Control of human toxocarosis relies on measures to reduce egg shedding by cats through regular periodic treatments with anthelminthics, or treatments based on the results of periodic diagnostic fecal examinations. Special emphasis should be given to kittens (lactogenic infection) where a fortnightly treatment can begin at 3 weeks of age, and to the control of stray cats.

To increase the awareness of potential zoonotic hazards, particularly amongst pet owners, veterinary practitioners, general practitioners and public health agencies should provide sufficient information and advice for appropriate measures to be taken to minimize the risk of infection. Recommendations include the following: be careful when in contact with young dogs and cats; wash hands before eating and after contact with animals; deworm dogs and cats regularly especially puppies and kittens; prevent children from eating earth and from playing on areas soiled with animal feces; remove pet feces; keep children's nails clipped and cover sandboxes (Overgaauw 1997).


FIGURE 2A & B → Cat defecating in playground (2A) and the non-visible result (2B) (Courtesy: Frans van Knapen).

## → Other nematodes

Other feline nematodes are sometimes considered as zoonotic, but zoonotic transmission is either rare, or likely to come from animal hosts other than from cats.

### → *DIROFILARIA REPENS* (SUBCUTANEOUS WORM)

*Dirofilaria repens* is a filaroid infection of the skin in dogs and cats in Europe, Asia and Africa with subcutaneously dwelling adult worms. The prevalences are low (0,2 – 0,5 %), but various mosquitoes can transmit subcutaneous *Dirofilaria* to the human (Rinaldi *et al.*, 2013). Zoonotic infection produces subconjunctival or subcutaneous swelling or nodules enclosing only one immature adult *D. repens*. The eye infections result in a worm that migrates across the conjunctiva or is encapsulated in a nodule on the conjunctiva or eyelid. The worm has also been reported from within the eye, either the anterior chamber or vitreous (Otranto and Eberhard, 2011).

The subcutaneous locations described are skulls, cheek, breast, inguinal area, buttocks, arms and legs. The infective larvae can have a

painful migration in the subcutaneous tissues before an erythemous nodule (1–6 cm of diameter) develops in the skin. The lesions are of little significance, and the majority of subcutaneous dirofilariosis is misdiagnosed as tumors or foreign body granuloma. The infection can be diagnosed by histological examination of the nodule or by extraction and morphological study of the worm. Blood eosinophilea or microfilariae are extremely rare (Marty, 1997). Anthelmintic treatment has no effect and surgical excision is required.

#### → *DIROFILARIA IMMITIS* (HEARTWORM)

The canine heartworm *Dirofilaria immitis* may infect many wild cats (ocelots, jaguars, lions, tigers, cougars, and leopards), both in the wild and in captivity in zoos. Nevertheless, the low or lack of microfilariae in the reported infections indicates that these hosts play no significant role in the transmission of this disease and cases of zoonotic transmission from cats are not reported (Simón *et al.*, 2012; Atkins, 2013).

#### → *TOXASCARIS LEONINA*

Adult *Toxascaris leonina* ascarids occurs in the small intestine of cats and various wild Felidae in most parts of the world. Infection with *T. leonina* in the definitive host is similar to *T. cati*, but the parasite is generally less pathogenic. The zoonotic potential of *T. leonina* is considered as absent or as very limited, because somatic migration in the definitive hosts does not occur as part of the normal life cycle, and larvae are not vertically transmitted (Overgaauw and Van Knapen, 2000). Studies to confirm the lack of the zoonotic potential are not published.

#### → *CAPILLARIA AEROPHILA*

The nematode parasite *Capillaria aerophila* is located in the respiratory tract of canines, felids and mustellids in North and South America, Europe, the Middle East, Russia, Asia, Australia, and parts of North Africa. The eggs are coughed up, swallowed and passed in the feces. The clinical symptoms are usually mild and consist of occasional coughing (Quinn *et al.*, 1997), but also rhinitis, tracheitis, bronchitis, bronchopneumonia has been described. Fatalities usually occur in animals less than 1 year of age. In a study in Serbia 10 free-living house cats were investigated by scraping the tracheal surface. Adult worms (both males and females with eggs) of *C. aerophila* were detected in all the animals (Laloševic´ *et al.*, 2008).
Pulmonary capillariosis in humans has been very rarely documented in Russia and the Ukraine, Morocco, Iran, Serbia, and France. The symptoms consist of bronchitis, coughing, mucoid or blood-tinged sputum, fever, dyspnea, and eosinophilia (Laloševic´ *et al.*, 2008). X-rays may show lung infiltrates. The diagnosis of human pulmonary capillariosis is by finding the eggs in sputum and or feces. Prevention consists of routine anthelmintic treatments of cats in endemic areas, strict personal hygiene by animal caretakers, avoiding the ingestion of soil, and preventing children from playing in high-risk areas (Nithikathkul *et al.*, 2011).

## → FELINE CESTODE ZOONOSES

Cats become infected with tapeworms by ingesting intermediate hosts that contain encysted juvenile tapeworms called larvae. The intermediate hosts, which are vertebrates in the case of *Taenia*, and *Mesocestoides* and insects in the case of *Dipylidium*, become infected by ingesting unhatched but infective tapeworm eggs discharged in the feces of the dog or cat. The relatively less common *Diphyllobothrium* and *Spirometra* tapeworms discharge eggs that must fall into water to undergo development in two or three aquatic intermediate hosts in series (Georgi, 1987).
In Table 2 an overview is presented of common feline cestode zoonoses.

### ↳ *Echinococcus multilocularis* (Fox tapeworm)

The tapeworm *Echinococcus multilocularis* is directly transmitted from pets to the human without the involvement of vectors or intermediate hosts and occurs in the northern hemisphere with endemic areas in Europe, Asia and North America. Cats are infected after eating intermediate hosts with metacestode stages in the liver containing protoscoleces (Eckert *et al.*, 2011). In Europe the intermediate hosts are predominantly voles that can be found in both rural and urban areas (Burlet *et al.*, 2011). The importance of Muridaea and especially the house mouse, which is a frequent prey of cats, is not confirmed sofar (Desplazes *et al.*, 2009).
The prevalence of *E. multilocularis* in cat populations, as determined at necropsy, ranged between 0-5.5 % in various endemic areas (Eckert *et al.*, 2011) and infections of cats are characterised by a low infection intensity. In one study a mean intensity of just nine worms per cat was found (Pétavy *et al.*, 2000). In an experimental study the average duration of excretion of 95 % of all eggs was 13 days for cats, compared with 43 days by dogs (Kapel *et al.*, 2006).
Although cats are likely to be infected with *E. multilocularis* more often than dogs, their zoonotic significance is estimated to be very low based on the low excretion of eggs (Desplazes *et al.*, 2012) (see chapter 1-02).

#### → ZOONOTIC INFECTION

Cat ownership within endemic areas is possibly a greater risk factor for human infection as well as households close to a landscape or biotype capable of sustaining susceptible intermediate host popula-

TABLE 2 → Overview of feline zoonotic cestodes.

| ANIMAL INFECTION | PARASITE | INTERMEDIATE HOSTS | HUMAN INFECTION | DISTRIBUTION |
|---|---|---|---|---|
| Echinococcosis | *Echinococcus multilocularis* | | Alveolar echinococcosis | Europe, Asia, N. America |
| Dipylidiosis | *Dipylidium caninum* | Fleas, lice | Dipylidiosis | Europe |
| Diphyllobothriosis Spirometrosis | *Diphyllobothrium latum* *Spirometra mansoni* | Copepod (*Cyclops*), amphibians, reptiles, mammals | Broad tapeworm | Russia, China, Japan, North & South America |
| | *S. erinacei* | | | Asia, Australia |
| | *S. mansonoides* | | | the Americans |

tions (Macpherson and Torgerson, 2012). Excreted eggs of taeniids by the cat are fully developed and infectious, so in endemic areas care should be taken with contact with cat feces (e.g. cleaning litter boxes). In contrast to dogs, where it is common to find eggs in the fur of infected animals, no eggs have been recovered to date from the coat of an infected cat (ESCCAP, 2010).

Human alveolar echinococcosis (AE) is a serious disease and lethal within 10 – 15 years if left untreated (Torgerson *et al.*, 2008). After peroral infection with eggs of *E. multilocularis* by the human, metacestodes almost exclusively develop primarily in the liver. The hydatid cysts has a very thin membrane, grow very slowly and proliferate in any direction or even to metastasize to distant organs such as the lungs or the brain. It is because of their appearance that they are called alveolar or multilocular cysts. There is little fluid in alveolar hydatids. As the disease progresses symptoms may occur, including hepatomegaly, abdominal pain, jaundice, sometimes fever and anemia (Eckert *et al.*, 2011). Radiographic examination, ultrasound or CT scan may discover the cysts, while serological tests are available for the diagnosis (John and Petri, 2006). The cysts may respond to treatment with albendazole, but the prognosis depends on the stage of disease at the time of the diagnosis.

Control is based on preventing cats preying on small mammals to reduce the risk of infection. Cats, in contrast to dogs, are epidemiologically insignificant as sources of egg output as they are poor hosts for this worm, although they do sporadically acquire infection and occasionally pass eggs. Since there is a small risk of cats carrying an infection, it is reasonable to recommend treatment with praziquantel or epsiprantel in high-risk situations, for example prior to entry into countries where the infection is not present (ESCCAP, 2010).

## ↳ *Dipylidium caninum* (dog & cat tapeworm)

*Dipylidium caninum* tapeworms are rarely associated with clinical signs in the dog or cat. This is one of the most common tapeworms of dogs or cats in the world and has the flea or the canine chewing louse as its intermediate host. Infection occurs as a result of ingesting infected insects (ESCCAP, 2010). More than 1% of fleas collected from dogs and cats in Europe are infected with *Dipylidium* (Beugnet *et al.*, 2013).

### → ZOONOTIC INFECTION

Very rarely the adult tapeworm may establish in humans, particularly small children under 6-12 months of age (Cabello *et al.*, 2011). The infection takes place through accidental ingestion of adult fleas that are infected with cysticercoids. The cat bites the fleas and the larval forms of the *D. caninum* stick to the teeth and contaminate the saliva (Ramana *et al.*, 2011). Ingestion is most likely to occur when children kiss or are licked by the cat (Molina *et al.*, 2003). Maturing of cesticercoids in the fleas is only possible when fleas have spent some time (around 36h) on their host. So the assumption that ingestion of infected flea larvae may play a role in the epidemiology is not correct (Beugnet *et al.*, 2013). As in animals, the larvae in the child grow to maturity in the small intestine, and gravid segments of the adult tapeworm continually detach single or in chains and migrate out of the anus, independently of stool, by contracting and expanding lengthwise (Molina *et al.*, 2003). The infection is often asymptomatic, but diarrhea, abdominal pain, and anal pruritis may occur. Diagnosis is made by finding the characteristic proglottids or, more rarely, egg packets in the stool (John and Petri, 2006). The treatment of choice for *D. caninum* infection is praziquantel. Niclosamide is also effective (Molina *et al.*, 2003). Infection of humans is self-limited unless there is repeated exposure from the environment. Preventing dipylidiosis in cats and humans requires from flea control, avoiding outdoor defecation of definitive hosts, deworming pets, and preventing children from playing with unknown (stray) animals (Cabello *et al.*, 2011).

## ↳ *Diphyllobothrium* spp.

The Diphyllobothriidean cestodes *D. latum* and *Spirometra* spp. have indirect life cycles that require two intermediate hosts before becoming infectious to the definitive host. Adult tapeworms are found in the small intestine of dogs or cats and other fish-eating mammals including man (Desplazes *et al.*, 2012). The tapeworm discharge eggs that are undeveloped when passed in the feces and must fall into water to undergo development to the coracidium stage. Copepods are the first intermediate hosts and aquatic vertebrates (fish, frog, water snake) are the final intermediate host containing the larva (plerocercoid) that is infective for the cat. Larger fish often ingests infected fish and may act as transport (paratenic). The plerocercoid will not continue to grow, but by this mechanism the transport host may become heavily infected (John and Petri, 2008). Cats are infected when they ingest the larval forms in the second intermediate or a transport host. The infection is not passed directly between cats and has been associated with mild gastrointestinal disease and weight loss (CAPC, 2012). Prevalences of *Diphyllobothrium* infection in cats are generally reported as low, such as 0,2 % in Korean feral cats (Sohn and Chai, 2005) and 0,1 % in household cats in Japan (Yamamoto *et al.*, 2009).

Cats become infected with *Spirometra* spp. when they ingest an infected vertebrate. Infective spargana may develop in amphibians, reptiles, birds, or mammals that ingest an infected copepod as first intermediate host or a transport vertebrate host. Domestic and wild carnivores like the cat are definitive hosts where the adult tapeworm lives in the small intestine. The bobcat (*Lynx rufus*) is thought to be the natural definitive host. Prevalences of *Spirometra* spp. infections in feral cats were reported as 18 % from Grand Cayman (Headley *et al.*, 2012) up to 41 % in Korea (Sohn and Chai, 2005).

### → ZOONOTIC INFECTION

*D. latum*, known as the 'broad or fish tapeworm', as the proglottids are usually wider than they are long, is the largest tapeworm of humans (several meters in length). It is found in northern temperate and subarctic and subantarctic countries with many lakes where fish is often eaten raw or only partially cooked. Cats infected with diphyllobothriidean cestodes do not create an immediate zoonotic risk because the stage that hatches from the eggs shed in pet feces are infectious only to the copepod first intermediate host. People are a normal definitive host of *D. latum* and may become infected upon ingestion of larvae in raw fish. Although infection is relatively harmless, it may produce in approximately 2 % of the patients pernicious anemia as result of extensive absorption of vitamin B12 by the adult tapeworm (Macpherson and Torgeson, 2012; John and Petri, 2008).

*Spirometra mansoni* is dominant in Asia and South America, *S. erinacei* in Asia and Australia, and *S. mansonoides* in the Americas. The tapeworms may infect people who inadvertently ingest infected drinking water containing infected copepods or by consuming raw intermediate hosts such as snakes or tadpoles. The larva penetrates the gut wall and migrates to the muscles and subcutaneous tissues. Another

way of infection occurs through the practice of placing poultices from infected frog or snake flesh on an ulcer, open wounds or other lesions, especially infected eyes, for medical reasons (often performed in China and South-East Asia). The disease is called sparganosis and the early migratory stages in the development of the sparganum are asymptomatic, but when it has reached its final site and begins to grow, its presence causes a painful inflammatory reaction in the surrounding tissues. Ocular sparganosis produces an intense reaction with periorbital oedema. Cerebral sparganosis is characterized by serious CNS symptoms (John and Petri, 2006).
Preventing and control measures include advising not to drink water from pounds and ditches, which may contain infected copepods. Fish should be deep frozen for minimal 24h or cooked appropriate before consumption, while cats should not be fed raw or undercooked fish or other vertebrate tissue. Regular treatment of infected animals with praziquantel can dramatically reduce environmental contamination of natural water resources with parasite eggs. Finally predation and scavenging activity by cats should be avoided by keeping them indoors (CAPC, 2012). Treatment is by surgically removing the plerocercoid and occasionally praziquantel may be used in heavy or cerebral infections (MacPherson and Torgeson, 2012).

# → FELINE TREMATODE ZOONOSES

Trematodes agents of zoonotic distomatosis are hermaphroditic flatworms. The group contains a very large number of species, those of medical or veterinary importance being mainly parasites of mammals (including humans) and/or birds as definitive hosts (see tables 3 & 4). The life cycle is frequently complex and still poorly described for many species. Typically definitive hosts disseminate the eggs from which a swimming embryo is produced. These embryos generally actively infest an aquatic gastropod as (first) intermediate host. The parasites then multiply in the snail, producing a sporocyst. Many sporocysts are produced and mother (primary) rediae emerge. The rediae asexually reproduce to daughter rediae, which also multiply then develop into a cercariae. Numerous cercariae finally escape from the snail in water. For many species there is a second intermediate host in which the cercariae enter to transform in infesting metacercariae. These second hosts are typically aquatic organisms mainly fish (occasionally amphibians, crustaceans or even molluscs). The fish can be passively infested (ingestion of cercariae in case of many of Heterophyidae) or actively by penetration of the skin (i.e. Opistorchiidae), and then metacercariae are located in muscles or under the skin. The definitive hosts are infested by ingestion of the second host, and then adult trematodes will develop in the definitive host. The trematodes found in cats may develop in the digestive tract (intestinal flukes), liver (biliary ducts) or pancreatic ducts, lungs (lung flukes), vascular venous plexus (blood flukes), and occasionally in nasal or oral cavities.

## ↳ Zoonotic infection

Food-borne trematodoses are a group of neglected tropical diseases (Utzinger, 2012). In the human, even if diseases like fasciolosis are of concern, the most important trematode infections are due to two host trematodes. Although these trematodes can be found worldwide, their importance has been mainly observed in human medicine in Asia were consumption of fish (particularly uncooked) is frequent. Foodborne trematode infection is a growing public health concern estimated to affect at least 40 million of persons with half a billion exposed, particularly in southeast Asia and western Pacific regions (Chen Jia *et al.*, 2012; Mayaudon, 1969; Fried *et al.*, 2004; WHO, 1995). It may also increase with the aquaculture development. In some regions the prevalence may reach 100 % of the population (i.e. parts of Vietnam) (Anh *et al.*, 2009; Utzinger, 2012). Humans in Southeast Asia are at risk for at least 70 species of trematodes (blood flukes, intestinal flukes, liver flukes and lung flukes), which are shared with a great variety of animals (Fürst *et al.*, 2012; WHO, 1995) and the differential diagnosis represents a major challenge. Consequently many zoonotic trematodes are commonly overlooked, leading to unreliable prevalence data, and underappreciating of their veterinary and public health burden and impact.
Additionally, many eggs are indistinguishable by microscopy resulting for instance in a risk for overestimation of *Clonorchis sinensis* prevalence or, in return, underestimation in case of minute intestinal flukes. Diagnosis is made difficult as the fecal egg detection, considered the diagnostic 'gold' standard, may lack of sensitivity. Morphological identification of eggs is virtually impossible for many species (only possible with adult flukes). Antibody tests could also lead to false positive or negative results. Polymerase chain reaction (PCR)-based diagnostics could help, but more knowledge is needed and the cost of these techniques still limits today a large-scale use of this approach (Johansen *et al.*, 2010). Consequently many epidemiological parameters are still lacking for estimating the distribution of these parasitic diseases characterized by highly focal spatial occurrence.

FIGURE 3 → *Clonorchis sinensis* (Courtesy Pr. Patrick Bourdeau).

TABLE 3 → Overview of feline trematodes (bold: most important known zoonotic species).

| LOCATION | FAMILY ↳ SUBFAMILY | GENUS | SPECIES |
|---|---|---|---|
| ORAL CAVITY | **Clinostomatidae** | ***Clinostomum*** | abdoni, falsatum, kalappahi |
| | **Cyathocolidae** | *Mesostephanus*<br>***Prohemistomum*** | milvi<br>***vivax*** |
| | **Diplostomatidae** | ***Alaria***<br>***Cynodiplostomum***<br>***Fibricola***<br>***Pharyngostomum*** | ***marcianae***<br>***azimi***<br>***minor***<br>***cordatum*** |
| | **Echinostomatidae** | ***Echinochasmus***<br>***Echinostoma***<br>***Artyfechinostoma***<br>***Episthmium***<br>***Stephanoprora***<br>*Isthmiophora*<br>*Echinoparyphium* | *brevivitellus, liliputanus,* ***perfoliatus,***<br>***ilocanum*** *,* ***revolutum***<br>***malayanum****, sufrartyfex*<br>***caninum***<br>*denticulatoides*<br>*melis* (?)<br>sp. |
| | **Gymnophallidae** | ***Gymnophalloides*** [3, 11] | ***seoi*** |
| | **Heterophyidae**<br>↳ Apophallinae | ***Apophallus*** (*Rossicotrema*) | ***donicus****, muehlingi, venustus* |
| | ↳ Ascocotylinae | ***Ascocotyle*** [4]<br>(= *Phagicola* = Parascocotyle) | *angrense, arnoldoi, ascolonga,* ***longa****, longicollis, minuta, pachycystis* |
| SMALL INTESTINE | ↳ Centrocestinae | ***Centrocestus***<br>***Pygidiopsis***<br>*Pygidiopsoides* | ***armatus****,* ***caninus****,* ***formosanum****, genata,* ***longus****, ormulus*<br>***summa***<br>*spindalis* |
| | ↳ Cryptocotylinae | ***Cryptocotyle*** | *concavum,* ***lingua****, quinqueangularis,* |
| | ↳ Euryhelminthinae | *Euryhelmis* | *monorchis, pacifica, squamula* |
| | ↳ Galactosominae | *Galactosomum* | *fregatae* |
| | ↳ Haplorchiinae | ***Haplorchis*** [5, 7]<br>***Procerovum***<br>***Stellantchasmus*** [12] | ***microrchis****, parataichui,* ***pumilio****, sprenti ,* ***taichui****,* ***yokogawai***<br>***calderoni****,* ***minutum****,* ***varium***<br>***amplicaecum****, falcatus* |
| | ↳ Heterophyinae | ***Heterophyes*** | *aequalis, continua,* ***heterophyes****,* ***nocens*** |
| | ↳ Metagoniminae | ***Metagonimus***<br>*Dexiogonimus* | ***minutus****,* ***takahashii****,* ***yokogawai***<br>*ciureanus* |
| | ↳ Stictodorinae | ***Stictodora*** | ***fuscata****, lari, sawakinenesis* |
| | | *Acanthotrema*<br>***Diorchitrema*** | *felis*<br>***formosanus****,* ***pseudocirratum*** |
| | **Microphallidae** | *Microphalloides* | *vajrasthirae* |
| | **Nanophyetidae** | *Nanophyetus* (*Troglotrema*) | *salmincola* |
| | **Neodiplostomidae** | ***Neodiplostomum*** | *seoulense* |
| | **Plagiorchidae** | *Plagiorchis* | *massino, muris* |
| BILIARY PANCREATIC DUCTS | **Dicrocoeliidae** | *Eurytrema* [9]<br>*Euparadistomum*<br>*Platynosomum* [2, 8] | *procyonis*<br>*buckleyi, heischi, pearsoni*<br>*concinnum, illiciens, fastosum* |
| | **Opisthorchidae** | ***Amphimerus*** | *pseudofelineus* |
| | | ***Clonorchis*** [6] | ***sinensis*** |
| | | ***Metorchis*** [1, 10] | *albidus,* ***conjunctus****, orientalis* |
| | | ***Opistorchis*** [6] | |
| | | *Parametorchis* | *complexus* |
| | | *Paropistorchis* | *caninus* |
| | | ***Pseudamphistomum*** [10] | ***truncatum*** |
| NASAL CAVITIES | **Orchipedidae** | *Orchipedum* | *isostoma* |
| | **Troglotrematidae** | *Troglotrema* | *mustelae* |
| LUNGS? | **Microphallidae** | *Microphalloides* | *vajrasthirae* |
| LUNGS | **Troglotrematidae** | ***Paragonimus*** | ***africanus****, amazonicus, caliensis,* ***heterotremus****, inca,* ***kellicotti****, mexicanus,* ***myiazakii*** *ohirai, peruvianus, pulmonalis, siamensis,* ***skrjabini****,* ***uterobilateralis****,* ***westermanni*** |
| | | ***Euparagonimus*** [14] | ***cenocopiosus*** |
| BLOOD VESSELS | **Schistosomatidae** | ***Schistosoma*** | ***japonicum*** |

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FIGURE 4 → *Echinostoma revolutum* (Courtesy Pr. Patrick Bourdeau).

Many of these trematode infections in humans may have cats as hosts and as potential indirect source. The cats play an important role only for some of these parasites and for most of them are only one possible host amongst a variety of wild or domestic mammals (including dogs, pigs, ruminants) or even birds that may, in return, play the major role. In most of the concerned areas, cats are still not really companion animals but rather stray cats and little is known on the real impact and prevalence of these parasites in owned cats (Chai *et al.*, 2013). In areas were the human trematode infection is not a major concern, the infestation of cats is just unknown. Comparatively to one intermediate host trematodes, the species that use two intermediate hosts have received little attention in veterinary medicine. This is the case of most of the parasites that can be found in domestic carnivores particularly cats. Cats are active predators on fish or amphibians an can be easily infested like a variety of other fish predators (Felidae, Mustelidae, Canidae, rodents, aquatic birds). Many of these trematodes may develop in several of these groups and their host specificity is much higher for the intermediate host.

The knowledge on feline trematodes is today still based mainly on results of studies performed in the epidemiology of human infection. There is virtually no data on the distribution in areas were trematode infection in human health is not a concern (and therefore neglected). Most of the information originated from necropsied stray cats (Sohn and Chai, 2005). The detection of these trematodes at adult stages is not easy, except in case of massive infestation, as many species measure one millimeter long or less. The eggs of trematodes have a wide range of size (20 to more than 100 µm); they are typically operculated, sometimes yellowish to brownish and very difficult to differentiate on simple morphological aspects. Moreover detection by coproscopic methods is difficult and of low sensitivity as the eggs of trematodes have a high density and are not detected by flotation methods commonly used for parasite investigation in cats. Sedimentation techniques, specifically conducted, are necessary to detect eggs, but are rarely used and need expertise. Trematode infections in cats are therefore considered to be underdiagnosed.

These trematodes form the largest group of helminth parasites in cats with more than one hundred species (Table 3). The list remains open. About fifty different species mainly Heterophyidae and Echinostomatidae develop in the small intestine, fifteen in the pancreatic or biliary ducts (mainly Opistorchiidae and Dicrocoelidae) and fifteen in the lungs (Troglotrematidae). Moreover some species may develop in oral or nasal cavities (i.e. *Clinostomum* sp.) or blood vessels. The list of the main group and species described in cats is indicated in Table 3. The definitive identification of trematodes is matter of specialist and controversies remains in the validation of some species. This makes the nomenclature of this group confusing. Molecular tools are progressively developed to help to discriminate species when morphology is not conclusive (Dongyou, 2013). These techniques are applied only on adult flukes and not still adapted for a diagnostic in vivo. The most important zoonotic trematodoses that may involve cats as indirect source are given below.

TABLE 4 → Characteristics of the most common feline trematode zoonoses.

| ANIMAL INFECTION | PARASITE | INTERMEDIATE HOSTS (DIRECT SOURCE) | HUMAN INFECTION | DISTRIBUTION |
|---|---|---|---|---|
| Echinostomatidosis | *Echinochasmus* | freshwater fish | Intestinal flukes | China,Korea,Japan, Egypt, Russia, Hungary, Denmark, Italy |
| | *Echinostoma* spp. | fish, tadpoles, snails, clams, mussels, frogs | | Brazil, Egypt, Asia, Philippines, Australia, Russia, Europe |
| | *Echinoparyphium* | Snails, tadpoles, frogs | | Indonesia |
| | *Artyfechinostoma* | Snails | | India, China, Indonesia, Thailand, Malaysia, Philippines |
| | *Isthmiophora* | Tadpoles, loaches, clams | | Europe, USA |
| Heterophyidosis | *Haplorchis* | Fresh/brackish water fish (Gambusia, Carps mullets) | Intestinal flukes | Asian Pacific (Philippines) |
| | *Heterophyes* | | | South east Asia, Peri-mediterranean & middle East (Greece to Tunisia), Peru |
| | *Metagonimus* | | | Southeast Asia : from Japan and Korea to India Spain, central Europe |
| Opisthorchiidosis | *Clonorchis* | Fish (cyprinidae, carps...) | Liver flukes | South East Asia |
| | *Opistorchis* spp. | | | Europe, Russia, India |
| | *Metorchis* | | | North & Central America |
| | *Pseudamphistomum* | | | Europe, Siberia, India |
| Paragonimosis | *Paragonimus* spp. | Crabs, Crayfish, shrimps | Lung flukes | China, Japan, Southeast Asia, Western tropical Africa, Ecuador, Peru, Venezuela, Mexico |

## ↳ Zoonotic infection of Heterophyidoses & Echinostomatidoses (intestinal flukes)

The intestinal flukes are digestive parasites found in humans in many tropical or temperate countries. They usually produce non-specific enteric diarrhoea with abdominal pain, lethargy, anorexia and weight loss. The parasites affecting both humans and possibly cats are found in 7 families, 2 of them being more prevalent: the Heterophyidae and Echinostomatidae.

The Heterophyidae comprise a very large number of species of minute intestinal Trematodes (10 subfamilies). Heterophyidae, even though many species measure less than 0.5 cm long, may often occur in very large number causing severe pathological changes.

Heterophyidae are parasites of various fish eating animals. Many species are able to develop in a variety of definitive hosts both mammals and birds (i.e. Ciconiiforms) indicating a relatively low specificity (Witenberg 1929). The first intermediate host is a brackish water snail and the second a fish (i.e. *Mugil* sp., Tilapias). Infestation in cats occurs after ingestion of metacercariae encysted in fish or amphibians. In the definitive host the development is direct and the parasite enters the Lieberkühn glands as soon as 3 days after infection. This can cause ulcers and inflammation. Amongst the parasites described in cats, the species from at least 12 different groups are also known to be parasite in humans (see Table 3). These trematodes are mainly distributed in southern and eastern Asia, China, Korea (Chai *et al.*, 1998, 2000 and 2004), Japan, Philippines (Belizario *et al.*, 2004). However some species have a much wider distribution. For instance *Heterophyes heterophyes* is also present in peri-Mediterranean countries (Israel, Egypt, Tunisia, Greece). Heterophiosis is due to several species of Heterophyes prevalent in Far and Middle East, Israel, Tunisia Egypt (Nile Delta), Sudan and southern Europe (Greece) (Chai *et al.*, 1986). *Metagonimus yokogawai* has been described in Israel, Spain, and central Europe. *Apophallus* sp. is another example of relatively non-specific worms. Cats are infested by ingestion of fish (catfish). Other hosts are dogs, raccoon, fox, seals, rodents and birds (heron).

These trematodes produce enteric diarrhoea with occasional complications. The poor adaptation to human beings could explain the abnormal migration and death in the intestinal mucosae. This produces intestinal damage that may result in liberation of eggs within blood and lymphatic streams. The embolization of eggs may induce non-digestive clinical signs (neurologic, cardiac). Extra-intestinal heterophyiasis is also a common manifestation in immunocompromised hosts. Cerebral cases have been described (*H. heterophyes* and *H. nocens*).

Echinostomidae are trematode parasites, common in birds and mammals, associated to freshwater habitats. The first intermediate host is often non-completely identified. Metacercariae develop in molluscs like gastropods or bivalves. The specificity to definitive host is quite low and distribution is mainly dependent of the abundance of snails as intermediate hosts. Infection in humans occurs after ingestion of raw or inadequately cooked food containing the metacercariae (fish, amphibians, snakes, clams or snails). It is also assumed that infection could occur by drinking water contaminated by metacercariae. The eggs are relatively large (60-150 µm in length) thin shelled, yellowish and containing an embryo. The opercule even present can be difficult to see.

A number of *Echinostoma* species may develop in humans in different parts of the world with various mammals as reservoir and indirect sources (Cross and Basaca-Sevilla, 1986). Cats and dogs are possible sources to the human. *Echinostoma revolutum* may use many gastropods as first intermediate host (*Physa occidentalis* and *Lymnaea stagnalis* in Eurasia, *Radix auricularia* in Europe Asia and the United States, *Corbicula* sp.). Cats and dogs are also possible sources for *E. malayanum*.

The infestation results from ingestion of raw snails or frogs. This parasite is predominantly found throughout North America. Reservoir hosts other than humans may play a major role. The symptoms of infection in humans are not specific, mainly emaciation fatigability and abdominal pain. More severe signs of enteritis or vomiting are occasional. The prevention of echinostomid infection in domestic animals could be included in the public health strategy.

## ↳ Zoonotic infection of Opistorchiidoses (liver flukes)

Several species of Opistorchiidae are responsible in human of hepatobiliary distomatoses. The most important are *Clonorchis sinensis* and *Opistorchis felineus* (and *O. viverrini*) (Petney *et al.*, 2013). These flukes are relatively large (8 to 25mm). Adults are located in biliary ducts of a variety of animals and humans.

The first intermediate hosts are typically snails (i.e. *Bithinia* sp.). The second intermediate hosts are various fish (i.e. *Cyprinids* sp. including carps) in which the cercariae encyst in metacercariae beneath the scales or in muscles. After ingestion the immature fluke reach the bile ducts from the intestine by retrograde migration. *Clonorchis sinensis* (cat, dog, pig, rat.), *Opistorchis felineus* (cat, dog, Mustelidae), *O. viverrini* (civet, cat) are the most important zoonotic species. Only *O. felineus* in Europe, some parts of Russia, Byelorussia and Ukraine, is predominantly zoonotic, while *O. felineus* in Asia and *C. sinensis* have a stronger mixture of zoonotic but also anthroponotic components in their life cycles (Wunderink *et al.*, 2014). *Opisthorchis viverrini* (Mekong area of south-eastern Asia) is predominantly anthroponotic. *Pseudamphistomum truncatum* is a parasite of the dog and cat (rarely of humans) found in Europe (i.e. British isles), Siberia and India. It has a life cycle and pathogenicity similar to those of *Opisthorchis* spp. In the human, the infestation is favorized by traditional consumption of raw or undercooked fish, where the metacercariae are not destroyed by marinades or some vinegar containing preparations. This results in a very high prevalence and possible massive infestation. The prepatent period is less than one month. The parasites then remain for years to decades. These long-lived flukes cause long-lasting chronic inflammation of the bile ducts, and this produces epithelial hyperplasia, periductal fibrosis and bile duct dilatation. The infestation causes mainly moderate non-specific digestive signs. Reinfections may result in colic and cholangitis crisis with fever, thinning, occasional icterus, and anaphylactic reactions (skin, pulmonary).

Signs of angiocholitis are accompanied with frequent icteria, hepatomegaly, abdominal pain, anemia and frequent hypereosinophilia. The classical complication is an evolution to cirrhosis. Opistorchiasis (both *C. sinensis* and *O. viverrini*, and possibly *O. felineus*) has been also shown to induce neoplasias (cholangiocarcinoma) decades after a chronic infection. The diagnosis is classically based on detection of small embryonated operculated eggs (25-30 µm). Ova of *C. sinensis* and *O. viverrini* are closely similar and, in practice, indistinguishable. The distinction is possible by comparing the morphologic differences in the adult forms or by serologic techniques.

In cats (and sometimes dogs) the flukes are known to be responsible of similar signs as in humans: abdominal pain, ascites, jaundice (Axelson, 1962).

## ↳ Zoonotic infection of Paragonimosis (lung flukes)

Paragonimus (Troglotrematidae) are bronchial parasites of many mammal species including Felidae, Canidae, Suidae, Muridae and accidentally humans. At least 15 species of Paragonimus have been described in cats. The adult flukes morphologically resemble to "coffee grain "(size, shape, and colour). The first intermediate hosts are freshwater gastropods Hydrobiidae (Melania, Tricula, Potadoma, Semisulcospira, Pomatiopsis) and the cercariae encyst in freshwater crustaceans (crabs, crayfish, shrimps). The infection generally occurs by ingestion of crustaceans (second intermediate host) although Suidae (including pigs) may serve as paratenic host (infection by ingestion of muscle infected by re-encysted metacercariae). Young flukes directly migrate from intestine to peritoneal cavity then diaphragm, lungs and bronchioles were they develop to adults. The parasites induce a tissue reaction (metaplasia) and the formation of cysts. Several species of Paragonimus are responsible in humans of pulmonary distomatoses mainly tropical/intertropical. They are very widely distributed:

1 → In many Asiatic countries: *P. westermani* (= *P. ringeri*), *P. heterotremus*, *P. miyazakii*, and *P. skrjabini* (mainly found in Japan, Korea, China, Philippines, Laos, Vietnam, India) (Chhabra *et al.*, 2013).

2 → In Africa: *P. africanus* and *P. uterobilateralis* (Nigeria, Gabon, Liberia, Guinea, Cameroun, and Ivory Coast).

3 → In the Americas: *P. kellicotti* and *P. rudis* (Peru, Venezuela, Mexico, and Ecuador).

*Paragonimus westermanni* is adapted to the human but also to Felidae. The clinical disease is mainly characterized by thoracic pain, cough and occasionally hemoptysis. Chronic infection may result in right heart failure. Secondary bacterial infection is common. Both the clinical signs and radiological aspect of nodules may mimic the evolution of tuberculosis. Aberrant locations are not rare, the most important being brain paragonimosis. The eggs of *Paragonimus* can be found by examination of sputum. They are large (80-100 µm), operculated and brownish. Serological tests (immune-electrophoresis) have been developed.

## ↳ Zoonotic infection of Diplostomidosis (visceral trematodosis)

*Alaria alata* is a trematode Diplostomatidae that develops in the small intestine of mainly dogs (and other Canidae) but also cats. The distribution of the parasite is very wide in Europe. The intermediate hosts are *Planorbidae* gastropods that produce furcocercariae. The furcocercariae then infest a second intermediate host (i.e. amphibian) in which a mesocercarial stage is formed. A third intermediate host (i.e. rodent) ingests the second and is infested by the metacercarial stage. Mesocercariae could also reencyst in a "paratenic host"; for instance in humans when the amphibian is ingested (i.e. improperly cooked frog's legs). Such paratenic host could be pigs, wildboars, cattle, deers, rabbits, and racoons. Finally the definitive host (cat, dog or wild Canidae like wolf, mink, muskrat, skunk, lynx) will prey a third host and the adult fluke develop in the small intestine (3-10 mm) in about 20 days. Large operculated eggs are found by faecal examination (98-134 µm x 62-68 µm). Human infection is called "mesocercariosis" and infection could occur by ingestion of both amphibian and paratenic host. In the human the disease resemble to "larva migrans" with various subcutaneous or visceral locations (hepatic, renal, pulmonary hemorrhages, intraocular or even encephalic) due to migration of mesocercariae. The clinical signs are occasionally very severe.

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gemeente
**Barneveld**

# Memo

*Datum:*
**24 mei 2019**

*Onderwerp:* parasieten in zandbakken en zandondergronden

*Ter attentie van:* gemeenteraad

*Afzender:* Marc Heijn

## Aanleiding

Naar aanleiding van de aanleg van de speelplek op de Slotstraat heeft de heer Overgaauw contact gezocht met de gemeente Barneveld over het toepassen van zand op de speelplek. De heer Overgaauw verricht sinds 1993 onderzoek naar de risico's van parasitaire besmetting van kinderen vanuit parken en zandbakken.

Vanwege deze zorg over parasitaire besmetting heeft de heer Overgaauw enkele artikelen aan de gemeente gestuurd om te wijzen op de gevaren van infectie met Toxoplasma en Toxocara. De artikelen van de heer Overgaauw zijn als bijlage toegevoegd aan dit memo.

De heer Overgaauw is betrokken bij Lokaal Belang. Tijdens de commissie samenleving heeft de Lokaal Belang de wethouder gevraagd om het gebruik van zand op speelplekken te heroverwegen.

De afdeling beheer heeft met interesse kennis genomen van de rapportages van de heer Overgaauw. De gemeente Barneveld volgt de discussie over microbiologische vervuiling van speelzand en kent de risico's van de aanwezigheid van parasieten in zand.

Over dit onderwerp zijn meerdere publicaties, richtlijnen en adviezen verschenen. Ingenieursbureau OBB heeft voor de gemeente Edam-Volendam een uitgebreide studie verricht. Daarbij zijn o.a. risico's, voordelen en richtlijnen ten aanzien van de toepassing van zand op speelplekken in kaart gebracht. Deze studie biedt ook aanknopingspunten voor de gemeente Barneveld. OBB heeft de gemeente Barneveld ondersteund bij het opstellen van het Speelruimtebeleid en heeft haar conclusies met de gemeente Barneveld gedeeld. U vindt het onderzoeksrapport

van OBB ter informatie ook als bijlage bij dit memo.

**Zand op speelplekken gemeente Barneveld**

De gemeente Barneveld voert voor het inrichten van speelplekken maatwerk per locatie. Dit doen we in overleg met bewoners. Dat geldt ook voor de toepassing van zand als (val)ondergrond. Hieronder gaan we in op de huidige praktijk en de argumenten die we als gemeente tegen elkaar afwegen ten aanzien van de toepassing als zand als ondergrond.

In de gemeente Barneveld passen wij op sommige speelplekken zand toe als speelzand of als ondergrond.

- Zandbakken met speelzand:

Dit type zandbak vraagt een hoge mate van hygiëne omdat kinderen hier echt actief met hun handen in het zand zitten. Je moet eigenlijk dagelijks controleren of het zand schoon is. Dit type zandbak kan de gemeente niet onderhouden omdat het te arbeidsintensief is. Er worden geen nieuwe zandbakken met speelzand aangelegd in de gemeente. Op sommige plekken zijn nog zandbakken aanwezig. Tijdens de uitvoering van het speelruimte beleidsplan worden de verschillende wijken bezocht. Hier geven we aan dat bestaande zandbakken alleen kunnen blijven als deze "geadopteerd" wordt door de buurt. Dat betekent dat de buurt zich organiseert en regelt dat de zandbak afgedekt wordt met een net en regelmatig controleert of de zandbak schoon is. Gebeurt dit niet dan haalt de gemeente de zandbak weg.

- Zand als valondergrond:

In het beheer- en uitvoeringsplan Ruimte voor Spelen staat hier het volgende over: *Het gebruik van zand als valdempende ondergrond is steeds minder gewenst vanwege hygiëneregels. Daarom worden de meeste zandondergronden naar de toekomst toe vervangen door kunstgras. Alleen daar waar de speelwaarde belangrijker is (natuurlijk spelen en zandbakken) zal het zand blijven bestaan.*

Het zand dat voor deze toepassing gebruikt wordt is grover en heeft een lager leemgehalte dan speelzand. Het is minder geschikt om mee te bouwen, maar door deze eigenschappen juist geschikt als veilige valondergrond. Het wordt daarom toegepast vanwege de valdempende waarde onder speeltoestellen die een valhoogte hebben die hoger is dan 1,50 meter.

Sinds 2008 mag onder toestellen tot een hoogte van 1,50 meter gras gebruikt worden als valondergrond. Voorheen was dit alleen bij toestellen tot 1 meter. Dit heeft er toe geleid dat er steeds vaker gras in plaats van zand, rubbertegels en kunstgras als valondergrond toegepast wordt.

**Maatregelen ten aan zien van hygiëne op speelplekken**

- Op alle speelplekken geldt een verbodsgebied voor honden. Bij alle speelplekken staat een bordje "verboden voor honden".
- Alle zandbakken/zandondergronden in de gemeente Barneveld worden eens per jaar doorgegraven.
- Op locaties waarvan bekend is dat er veel vervuiling door katten is wordt regelmatig de poep uit de zandbak / de zandondergrond geschept.

- Elke speelplek wordt in verband met veiligheidsinspecties van de toestellen in ieder geval 4 keer per jaar bezocht.

**Argumenten vanuit spelen / beheer/ ontwerp**

Zoals aangegeven gaat de gemeente Barneveld terughoudend om met de toepassing van speelzand en zand als valondergrond. Toch voegen we soms zand toe aan het ontwerp voor een nieuwe speelplek, of laten we een bestaande zandondergrond bestaan. Hiervoor zijn verschillende argumenten.

- *Veiligheid*
  Zand heeft de beste valdemping. Bij toestellen hoger dan 1,50 meter kiezen we daarom voor zand.

- *Speelwaarde*
  Spelen met zand bevordert de motorische en cognitieve vaardigheden van het kind. Bij de participatietrajecten voor het inrichten van speelruimtes wordt door deelnemers vaak gevraagd naar het toevoegen van zand.

- *Duurzaamheid*
  Vanuit oogpunt duurzaamheid is de keuze voor zand logisch. Zand is recyclebaar terwijl kunstgras bijna niet wordt gerecycled.

- *Ontwerp/uitstraling speelplek*
  Bewoners kiezen tijdens schetsavonden vaak voor een natuurlijke uitstraling van de speelplek. Daar past een zandondergrond beter bij dan kunstgras of rubber.

- *Budget*
  Als valondergrond is zand budgettair gezien voordeliger dan rubber of kunstgras. Door zand te gebruiken in plaats van kunstgras, kan er meer geïnvesteerd worden in de speelwaarde van de plek.

**Conclusie**

Het is bij de ontwerpers en bij de beheerders van speelplekken in de openbare ruimte in de gemeente Barneveld bekend dat er (beperkte) gezondheidsrisico's zijn bij het gebruik van zand op de speelplek.

De afdeling Beheer Openbare Ruimte is van mening dat het risico van besmetting beperkt kan worden door enerzijds terughoudend om te gaan met de toepassing van speelzand, en anderzijds in te zetten op goede informatievoorziening en afspraken met inwoners.

Soms zijn er argumenten die er toe leiden dat er op een specifieke speelplek toch zand wordt toegepast als ondergrond. Deze argumenten worden steeds zorgvuldig afgewogen in overleg met omwonenden.

Het is belangrijk dat deze toepassing dan wordt gecombineerd met hygiënemaatregelen. Dat geldt voor de afdeling beheer, maar ook vanuit inwoners. Daarom is goede voorlichting richting bewoners over de risico's en maatregelen essentieel.

De komende periode zal vanuit de gemeente Barneveld extra worden ingezet op communicatie richting inwoners over de adviezen met betrekking tot de hygiëne rond speelplekken, zoals handen wassen door kinderen. Ook het ontwormen van huisdieren kan de kans op besmetting verkleinen.

Deze adviezen zijn ook door minister Schippers aangehaald bij de beantwoording van vragen van D66 over besmette zandbakken (15 juni 2016). Deze vragen en antwoorden zijn ook als bijlage bijgevoegd

De communicatie hierover vindt plaats via de gemeentelijke kanalen en tijdens de particpatietrajecten met bewoners rondom de herinrichting van speelplekken.