



Collegiate Turf Bowl Competition Study Guide

GCSAA would like to thank Leah Brilman, Ph.D., turfgrass product manager DLF USA, and Gwen Stahnke, Ph.D., facilitators of the Turf Bowl, for their work updating and modifying the exam each year.

The 2026 Turf Bowl Competition will consist of a single exam that will be administered electronically. It will include multiple choice questions covering the areas of study listed in this study guide and the physical and visual identification of samples. The top 10 teams will earn prizes.

Eligibility

To participate in the GCSAA Collegiate Turf Bowl Competition, students must meet all the following eligibility criteria:

- Must be currently enrolled in a turf program or have graduated at the end of the most recent fall semester but have not
- yet entered a graduate program
- Be an active Student member with GCSAA
- Be a registered attendee at the GCSAA Education Conference and Golf Industry Show

Important Dates

- December 1, 2025
 - Team rosters with captains identified due to Leann Cooper at lcooper@gcsaa.org
- February 4, 2026
 - Turf Bowl Breakfast – 8:00 – 8:45 a.m. Orlando Convention Center
 - Turf Bowl exam – 9:00 a.m. – 12:00 p.m. Orlando Convention Center
- February 5, 2026
 - Results announced at GCSAA Closing Session 1:15 – 2:30 pm Orlando Convention Center

Areas of Study

Turfgrass Identification

- Identify turf specimens by their common names or traits.
- Know common name vs. scientific name.
- Identify seed of turfgrass species
- For specific turfgrass species, please see Addendum 1.

Turfgrass Growth and Development

- Identify parts of the grass plant.
- Know management and environmental factors that influence growth.
- Understand turfgrass physiology and how it is influenced by management practices.
- Understand plant growth regulators – Use and influence on biology
- Clipping Volume on putting greens – measurement and use

Turfgrass Soils and Soil Fertility

- Know greens construction, particle sizes, soils and fertility.
- Know of macronutrients and micronutrients, and their influence on growth.
- Soil types and classification
- Read and interpret a soil report
- Organic matter measurements – types and use

Weed Identification and Control

- Identify common weeds. Note: Any turfgrasses on list can also be weeds.
- Know herbicides, what weeds they control and mode of action.
- Know the life cycle of
- weeds and how management influences weed growth.
- Know seed labeling for crops and weeds.
- For specific weeds, please see Addendum 2.

Turfgrass Diseases

- Identify common diseases.
- Know environmental and management conditions, and the types of diseases that the conditions favor.
- Know common fungicides.
- Know grass species corresponding to various diseases.
- Nematodes and various Abiotic stresses may be under Diseases
- For specific diseases and nematodes, please see Addendum 3.

Turfgrass Mathematics

- Calculate application rates of chemicals and fertilizers.
- Know quantities of sand and seed to use.
- Know how to correctly calibrate application equipment.
- Know how to use both the Metric and English units in calculations.

Turfgrass Insects

- Identify photos of larval and adult forms of insects that attack turf.
- Know life cycles, preferred foods, feeding methods and other characteristics important in controlling insects.
- For specific insects, please see Addendum 4.

Irrigation

- Know how to evaluate turfgrass water needs and adjust various irrigation methods and rates accordingly to ensure the efficiency and effectiveness of the irrigation system.
- Calculate water usage.
- Know the basics of using reclaimed water for irrigation.

Water Management

- Understand how turfgrasses process water, including transpiration.
- Understand water terminology
- Know the symptoms of water stress in various turfgrasses and how to remedy.
- Know the causes of pesticide and nutrient runoff and how to prevent.
- Understand wetting agents – causes of Localized Dry Spot (LDS)

New technology

- Robot mowers – types and uses, benefits and problems
- Sprayers with GPS, Computers
- Use of GS3 ball to improve greens – what do the numbers mean
- Moisture measurement- inground and portable measurement devices
- Irrigation Controllers
- Use of drones on golf course – potential to improve management

Resources

The following resources, along with GCSAA's monthly publication *Golf Course Management* magazine, are recommended as study resources. The textbooks may be available through your school library, local bookstore or through the **GCSAA Store online** at <https://www.gcsaastore.com/>.

1. **The Mathematics of Turfgrass Maintenance (3rd Edition)** – Michael Agnew and Nick Christians
2. **Mathematics for the Green Industry: Essential Calculations for Horticulture and Landscaping Professionals** - Michael Agnew, Nancy Agnew, Ann Marie VanDerZanden and Nick Christians
3. **Turfgrass Management (Edition 1.0)** – A.J. Turgeon and J.E. Kaminski,
<https://turfpath.com/book/>
4. **Fundamentals of Turfgrass Management (5th Edition)** – Nick Christians
5. **Turf Management for Golf Courses (2nd Edition)** – James B. Beard
6. **Salt-Affected Turfgrass Sites: Assessment and Management** – R.N. Carrow and R.R. Duncan
7. **Managing Turfgrass Pests (2nd Edition)** – Thomas L. Watschke, Peter H. Dernoden and David J. Shetlar
8. **Controlling Turfgrass Pests (3rd Edition)** – Thomas W. Fermanian, Malcom C. Shurtleff, Roscoe Randell, Henry T. Wilkinson and Philip L. Nixon
9. **Creeping Bentgrass Management: Summer Stresses, Weeds and Selected Maladies (2nd Edition)** – Peter H. Dernoden
10. **Human Resource Management for Golf Course Superintendents, ch. 6** – Bob Milligan and Tom Maloney
11. **Superintendents Handbook of Financial Management (Revised Edition), ch. 2, 3, 5, and 9** – Ray Schmidgall
12. **The Turf Problem Solver: Case Studies and Solutions for Environmental, Cultural and Pest Problems** – A.J. Turgeon and J.M. Jr. Vargas (Dec. 2, 2005)
13. **Identifying Turf and Weedy Grasses of the Northern United States** – D. Pedersen and T. Voight Illinois Pocket ID series University of Illinois Extension
<https://pubsplus.illinois.edu/collections/gardening/products/identifying-turf-weedy-grasses-of-northern-us>
14. **Turfgrass Insects of the United States and Canada (3rd Edition)** – Patricia J. Vittum

15. **Turfgrass Identification** (version)- David Gardner, The Ohio State University
buckeyeturf.osu.edu/pdf/01_turfgrass_identification.pdf
16. **Handbook of Turfgrass Insects** (2nd Edition) – Edited by Rick L. Brandenburg and Callie P. Freeman, 2012
17. **A Practical Guide to Turfgrass Fungicides** (2nd Edition) by Richard Latin, 2021
18. **Compendium of Turfgrass Diseases** (4th Edition) – Edited by Lane P. Tredway, Maria Tomaso-Peterson, James P. Kerns, and Bruce B. Clarke, 2023
19. Best Management Practices for Turfgrass Water Conservation
commodities.caes.uga.edu/turfgrass/georgiaturf/Publicat/1650_BMP_H2O.htm
20. Best Management Practices: Planning Guide & Template – GCSAA
https://www.gcsaa.org/docs/default-source/environment/bmp-planning-guide_2023_print_final.pdf?sfvrsn=f174c03e_1
21. Golf Course Environmental Profile <https://www.gcsaa.org/what-we-do/environmental-stewardship/golf-course-environmental-profile>
22. **Golf Turf Management** – L.B. (Bert) McCarty, 2018
23. **Practical Golf Course Maintenance: The Art of Greenkeeping** (4th Edition) – Michael Bavier, CGCS Retired, and Luke Cella, CGCS
24. Nematode Management For Golf Courses In Florida – William T. Crow
<https://edis.ifas.ufl.edu/publication/IN124>
25. Guide for Interpreting Nematode Assay Results – University of Georgia Extension
<https://extension.uga.edu/publications/detail.html?number=C834&title=guide-for-interpreting-nematode-assay-results>
26. Key to the Most Common Genera of Plant-Parasitic Nematode (located at the end of the Turf Bowl Study Guide)
27. Pacific Shoot-Gall Nematode *Anguina pacifica* – University of Florida Extension (located at the end of the Turf Bowl Study Guide)
28. Robotic Mowers - <https://doi.org/10.1002/csc2.70081>
29. GS3 – Understanding the numbers <https://www.usga.org/content/usga/home-page/course-care/green-section-record/62/issue-22/g3--understanding-the-numbers.html>
30. Moisture Meters – How they work and How to get best out of them
<https://www.usga.org/content/usga/home-page/course-care/green-section-record/63/issue-15/moisture-meters--how-they-work-and-how-to-get-the-best-data-from.html>

31. Are you managing Organic Matter or is it managing you.

<https://www.usga.org/content/usga/home-page/course-care/green-section-record/62/issue-22/are-you-managing-putting-green-organic-matter-or-is-it-managing-.html>

Addendum 1

Cool Season Grasses

Common name	Scientific name
1. Kentucky bluegrass	<i>Poa pratensis</i>
2. Perennial ryegrass	<i>Lolium perenne</i>
3. Tall fescue	<i>Festuca arundinacea</i> = <i>Schedonorus arundinaceus</i> = <i>Lolium arundinaceum</i>
4. Hard fescue	<i>Festuca brevipila</i> (<i>F. trachyphylla</i>)
5. Chewings fescue	<i>Festuca rubra</i> ssp. <i>commutata</i> (ssp. <i>fallax</i>)
6. Creeping bentgrass	<i>Agrostis stolonifera</i>
7. Colonial bentgrass	<i>Agrostis capillaris</i>
8. Strong creeping red fescue	<i>Festuca rubra</i> ssp. <i>rubra</i>
9. Slender creeping red fescue	<i>Festuca rubra</i> ssp. <i>littoralis</i>
10. Velvet bentgrass	<i>Agrostis canina</i>
11. Rough bluegrass	<i>Poa trivialis</i>
12. Annual bluegrass	<i>Poa annua</i>
13. Annual ryegrass	<i>Lolium multiflorum</i>

Warm Season grasses

14. Japanese / Korean lawngrass	<i>Zoysia japonica</i>
15. Manilla grass	<i>Zoysia matrella</i>
16. Hybrid bermudagrass	<i>Cynodon dactylon</i> X <i>C. transvaalensis</i>
17. Common bermudagrass	<i>Cynodon dactylon</i> var. <i>dactylon</i>
18. Centipedegrass	<i>Eremochloa ophiuroides</i>
19. Seashore paspalum	<i>Paspalum vaginatum</i>
20. Buffalograss	<i>Bouteloua dactyloides</i>
21. St. Augustinegrass	<i>Stenotaphrum secundatum</i>
22. Kikuyugrass	<i>Pennisetum clandestinum</i>

- 23. Bahiagrass
- 24. Carpetgrass
- 24. Blue grama
- 25. Sideoats grama

- Paspalum notatum*
- Axonopus affinis*
- Bouteloua gracilis*
- Bouteloua curtipendula*

Addendum 2

Weeds

- Alkaligrass
- Barnyardgrass / Watergrass
- Bedstraw / Catchweed
- Bindweed, Field
- Brassbuttons, Souther
- Buttonweed, Virginia
- Carpetweed
- Carrot, Wild
- Chess, Soft
- Chickweed, Common
- Chickweed, Mouseear
- Chicory
- Clover, White
- Crabgrass, Hairy (Large)
- Crabgrass, Smooth
- Cudweed, purple
- Dallisgrass (smooth paspalum)
- Dandelion, False /spotted catsear
- Dandelion
- Dichondra
- Dock, Curly
- Downy Brome / cheatgrass
- English Daisy
- Foxtail, Yellow (pigeon / bristle grass)
- Foxtail , Green
- Garlic , Wild
- Geranium, Carolina / dovefoot
- Goosegrass/Silver Crab/ Crowfoot
- Ground Ivy (Creeping Charlie/Jenny)
- Hawkweed
- Henbit
- Johnsongrass
- Khaki weed

- Puccinella distans*
- Echinochloa crus-galli*
- Galium aparine*
- Convolvulus arvensis*
- Cotula australis*
- Diodia virginia*
- Mollugo verticillata*
- Daucus carota*
- Bromus hordeaceus*
- Stellaria media*
- Cerastium vulgatum*
- Cichorium intybus*
- Trifolium repens*
- Digitaria sanguinalis*
- Digitaria ischaemum*
- Gnaphalium purpureum*
- Paspalum dilatatum*
- Hypochoeris radicata*
- Taraxacum officinale*
- Dichondra repens*
- Rumex crispus*
- Bromus tectorum*
- Bellis perennis*
- Setaria glauca (pumilla ssp pumilla)*
- Setaria viridis*
- Allium vineale*
- Geranium ssp.*
- Elusine indica*
- Glechoma hederacea*
- Hieracium pratense*
- Lamium amplexicaule*
- Sorghum halapense*
- Alternanthera pungens*

Kikuyugrass
Knotweed, Prostrate / Common
Kochia
Kyllinga, Annual / Fragrant
Kyllinga, Green / Perennial
Lambsquarter
Lettuce, Prickly
Mallow, Common
Medic, Black
Medic, Burr/Burr Clover
Moss, silvery thread
Mullein, Common
Nimblewill
Nutsedge, Purple
Nutsedge, Yellow
Oats, Wild
Orchardgrass
Pearlwort
Pennywort / dollarweed
Peppergrass / pepperweed
Pigweed, Prostrate
Pineapple Weed / wild chamomile
Plantain, Broadleaf
Plantain, Buckhorn / Narrowleaf
Puncture Vine / goatshead
Purslane, common
Quackgrass
Rattail fescue
Redtop
Salsify, Western
Sandbur/ grassbur
Sedge, Annual
Shepherd's Purse
Signalgrass
Smartweed, Spotted (Ladysthumb)
Smutgrass
Sorrell, Red / Sheeps
Speedwell, creeping
Spurge, Prostrate / Spotted
Star of Bethlehem
Strawberry, Wild

Pennisetum clandestinum
Polygonum aviculare
Kochia scoparia
Kyllinga odorata
Kyllinga brevifolia
Chenopodium album
Lactuca serriola
Malva neglecta
Medicago lupulina
Medicago polynorpha
Bryum argenteum
Verbascum thapsus
Muhlenbergia schreberi
Cyperus rotundus
Cyperus esculentus
Avena fatua
Dactylis glomerata
Sagina apetala (procumbens)
Hydrocotyle umbellata
Lepidium virginicum
Amaranthus blitoides
Matricaria discoidea
Plantago major
Plantago lanceolata
Tribulus terrestris
Portulaca oleracea
Elytrigia repens
Vulpia myuros
Agrostis gigantea (alba)
Tragopogon dubius
Cenchrus incertus
Cyperus compressus
Capsella bursa-pastoris
Urochloa subquadripara
Polygonum persicaria
Sporobolus indicus
Rumex acetosella
Veronica filiformis
Chamaesyce maculata (Euphorbia)
Ornithogalum umbellatum
Fragaria virginiana

Swinecress
 Timothy
 Thistle, Bull
 Thistle, Canada
 Thistle, Musk
 Torpedograss
 Velvetgrass, German
 Violet
 Woodsorrel, Creeping
 Woodsorrel, Yellow (Oxalis)
 Yarrow
 Yellowcress

Coronopus didymus
Phleum pratense
Cirsium vulgare
Cirsium arvense
Carduus nutans
Panicum repens
Holcus mollis
Viola ssp.
Oxalis corniculata
Oxalis stricta
Achillea millefolium
Rorippa palustris

Addendum 3

Bacterial Diseases

Bacterial wilt
 Bacterial etiolation and decline

Xanthomonas translucens
Acidovorax avenae

Fungal Diseases

Anthraxnose
 Ascochyta leaf blight
 Bermudagrass decline
 Blister smut
 Brown patch (C3) & large patch (C4)
 Brown ring patch
 Brown stripe
 Cladosporium eyespot
 Copper spot
 Coprinus snow mold
 Crown rust
 Curvularia blight
 Dead spot
 Dollar spot

Colletotrichum cereale, *C. eremochloae*
Ascochyta avenae
 See Root decline of warm-season grasses
Jamesdicksonia dactylidis
Rhizoctonia solani
Waitea circinata var. *circinata*
Mycosphaerella recutita
Cladosporium phlei
Gloeocercospora sorghi
Coprinopsis psychromorbida
Puccinia coronata
 multiple *Curvularia* sp.
Ophiosphaerella agrostis
Clariireedia is new genus
Clariireedia homeocarpa on *Festuca rubra*,
 UK only
Clariireedia bennettii on mostly cool season
 grasses, UK, Netherlands, USA
Clariireedia monteithiana on Warm-season
 grasses; found worldwide
Clariireedia jacksonii on cool-season grasses;
 found worldwide
 multiple *Drechslera* and *Mariellottia* sp.

Drechslera leaf spots and melting-out

Endophytic fungi	<i>Neotyphodium coenophialum</i> , <i>N. lolii</i> , <i>Epichloe typhina</i>
Fairy ring	Species of Agaricales and Gastromycetales, mostly in the genera <i>Agaricus</i> , <i>Calvatia</i> , <i>Chlorophyllum</i> , <i>Clitocybe</i> , <i>Lepiota</i> , <i>Lycoperdon</i> , <i>Marasmius</i> , <i>Scleroderma</i> , and <i>Tricholoma</i> .
Flag smut	<i>Urocystis agropyri</i>
Gray leaf spot	<i>Pyricularia grisea</i>
Gray snow mold	<i>Typhula incarnata</i>
Leaf and sheath spot (Mini-ring)	<i>Waitea circinata</i> var. <i>zeae</i> , <i>W. circinata</i> var. <i>oryzae</i>
Leaf rust	<i>Puccinia brachypodii</i>
Leptosphaerulina leaf blight	<i>Leptosphaerulina trifolii</i>
Mastigosporium leaf spot (leaf fleck)	<i>Mastigosporium rubricosum</i>
Microdochium patch	<i>Microdochium nivale</i>
Necrotic ring spot	<i>Ophiosphaerella korrae</i>
Phyllosticta leaf blight	Multiple species of <i>Phyllosticta</i> and <i>Guignardia</i>
Physoderma leaf spot and leaf streak	<i>Physoderma graminis</i>
Pink patch and cream leaf blight	<i>Limonomyces roseipellis</i>
Pink snow mold	See Microdochium patch
Powdery mildew	<i>Blumeria graminis</i>
Pythium foliar blight	<i>Pythium aphanidermatum</i> , <i>P. graminicola</i> , <i>P. ultimum</i> , Several other <i>Pythium</i> species
Pythium root and crown rot	<i>Pythium aristosporum</i> , <i>P. arrhenomanes</i> , <i>Pythium volutum</i> , several other <i>Pythium</i> species
Pythium root dysfunction:	<i>Pythium volutum</i> , <i>P. arrhenomanes</i> , <i>P.</i> <i>aristosporum</i> , several other <i>Pythium</i> species
Rapid blight	<i>Labyrinthula terrestris</i>
Red thread	<i>Laetisaria fuciformis</i>
Root decline of warm-season grasses	<i>Gaeumannomyces graminis</i> var. <i>graminis</i> , <i>Magnaporthiopsis incrustans</i> , <i>G. wongoonoo</i>
Septoria leaf spot	several <i>Septoria</i> species
Snow scald	<i>Sclerotinia borealis</i>
Southern blight	<i>Athelia rolfsii</i>
Speckled snow mold	<i>Typhula ishikariensis</i>
Spring dead spot	<i>Ophiosphaerella narmari</i> , <i>O. korrae</i> , <i>O. herpotricha</i>
Stem rust	<i>Puccinia graminis</i>
Stripe rust	<i>Puccinia striiformis</i>
Stripe smut	<i>Ustilago striiformis</i>
Summer patch	<i>Magnaporthiopsis poae</i>
Take-all patch	<i>Gaeumannomyces graminis</i>
Tar spot	<i>Phyllachora</i> spp.

Thatch collapse
Yellow patch
Yellow tuft
Yellow ring

Sphaerobolus stellatus
Rhizoctonia cerealis
Sclerophthora macrospora .
Trechispora alnicola

Nematodes, Parasitic

Awl: *Dolichodorus* spp. Cobb
Cyst: *Heterodera* spp. Schmidt
Dagger: *Xiphinema* spp. Cobb
Lance: *Hoplolaimus* spp. Daday
Lesion: *Pratylenchus* spp. Filipjev
Needle: *Longidorus* spp. (Micoletzky) Thorne & Swanger
Pacific Shoot Gall: *Anguina pacifica*
Pin: *Paratylenchus* spp.
Pseudo-root knot: *Hypsoperine* spp. Sledge & Golden
Ring: *Criconemella*, *Criconemoides*, *Macroposthonia*, and *Mesocriconema* spp.
Root gall: *Subanguina* spp.
Root knot: *Meloidogyne* spp. Goeldi
Sheath: *Hemicycliophora* spp.
Sheathoid: *Hemicriconemoides* spp.
Spiral: *Helicotylenchus* spp. Steiner
Sting: *Belonolaimus* spp. Steiner
Stubby root: *Paratrichodorus* and *Trichodorus* spp.
Stylet or stunt: *Tylenchorhynchus* spp. Cobb

Miscellaneous Diseases or Disorders

Black Layer: A

Anaerobic soil plus blue-green algae and/or sulfate-reducing bacteria

Slime Molds (superficial, not pathogenic):

Mucilago crustacea

: *Didymium squamulosum*

: *Physarum cinereum*.

: Species of *Physarum* and *Fuligo*

Addendum 4:

Insects

Annual Bluegrass Weevil

Billbugs

- bluegrass billbug

- hunting billbug
- Denver/Rocky Mountain billbug
- Phoenix billbug

Black Turfgrass Ataenius

Flea Beetle

Chinchbugs

- hairy chinchbug
- southern chinchbug

Craneflies

- European crane fly (*Tipula paludosa*)
- "common" crane fly (*Tipula oleraceae*)

Caterpillars and adults

- armyworm
- black cutworm
- fall armyworm
- winter cutworm
- sod webworm

Mole Crickets

- southern mole cricket
- northern mole cricket
- tawny mole cricket

Ant

- red imported fire ant
- turfgrass ant
- formica ant

White Grubs and Adult Beetles

- Asiatic garden beetle
- European chafer
- Japanese beetle
- masked chafer (southern)
- masked chafer (northern)
- masked chafer (western)

- masked chafer (southwestern)
- sugarcane beetle
- Green June beetle
- May/June beetle
- Oriental beetle

Mites

- Stunt (Bermuda)
- Banks grass

Wasps

- Scoliid
- Cicada Killers
- yellow jacket
- Paper wasp

Two-lined spittlebug

Rhodesgrass Mealybug

Groundpearl (pearl scales)

Wireworm

Beneficials

Honey bees

Assassin bugs

Ground beetle

Lacewing

Praying Mantis

Rove beetles

Big Eyed bug

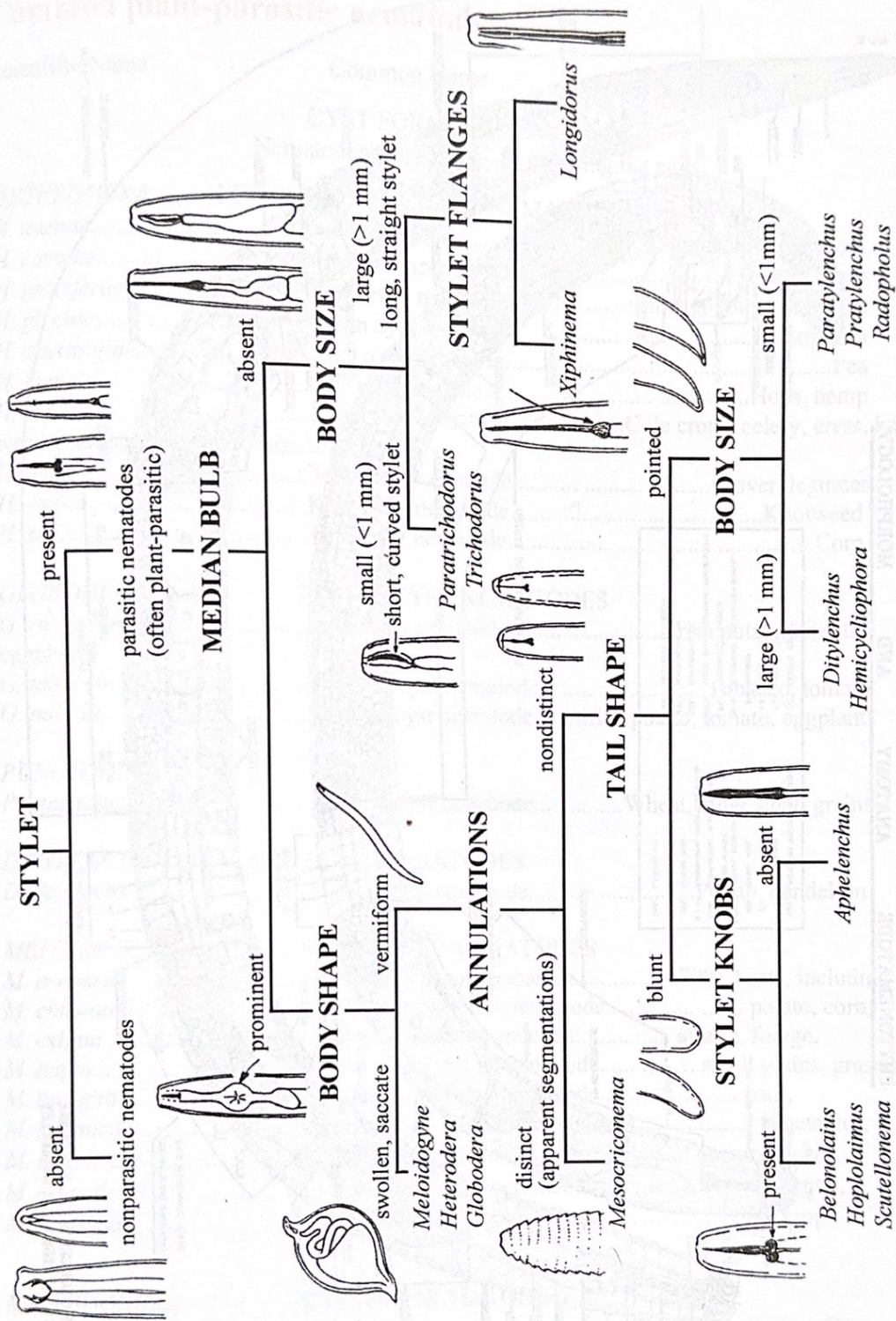
Key to the most common genera of plant-parasitic nematodes

1. Stylet absent.....non-parasitic nematodes
- 1'. Stylet present: Mainly plant-parasitic nematodes.....2
2. Two-part esophagus, median bulb absent; odontostyle;.....Dorylaimida.....3
- 2'. Three-part esophagus, distinct metacarpus; stomatostyle;.....Tylenchida.....5
3. Stylet long, straight; body long, slender; very large nematodes;Longidoridae.....4
- 3'. Stylet short, curved, weak; body short, thick;.....Trichodoridae.....*Trichodorus*
Paratrichodorus
4. Stylet with flanges, guiding ring near base.....*Xiphinema*
- 4'. Stylet without flanges, guiding ring near apex.....*Longidorus*
5. Metacarpus more than 3/4 body width; DGO in metacarpus;.....Aphelenchina.....6
- 5'. Metacarpus less than 3/4 body width; DGO in procorpus;Tylenchina.....7
6. Female tail blunt, male without bursa; Aphelenchidae.....*Aphelenchus*
- 6'. Female tail conoid with mucro, male without bursa;*Aphelenchoides*
Aphelenchoididae
7. Procorpus separated from metacarpus.....8
- 7'. Procorpus fused with metacarpus; Criconematidae.....21
8. Female vermiform; Tylenchoidea.....9
- 8'. Female swollen; Heteroderoidea.....19
9. Stylet very long; head region distinctly rounded;Belonolaimidae.....10
- 9'. Stylet moderately long to short.....11
10. Tail rounded.....*Belonolaimus*
- 10'. Tail pointed.....*Dolichodorus*
11. Stylet weak;Tylenchidae.....12
- 11'. Stylet strong;.....13
12. Tail subacute, pointed; vulva in posterior 1/3.....*Ditylenchus*
- 12'. Tail filiform, more than 6x body width at anus.....*Tylenchus*
13. Vulva in middle of body;Tylenchorhynchidae...*Tylenchorhynchus*
- 13'. Vulva in posterior of body.....14
14. Stylet strong; 2 ovaries; female tail less than BWA;.....Hoplolaiminae.....15
- 14'. Stylet relatively strong; head flattened;.....Pratylenchinae.....18
15. Scutellae.....16
- 15'. Phasmids.....17
16. Anterior and posterior to vulva.....*Hoplolaimus*
- 16'. Both in anal region.....*Scutellonema*

17. Ventral overlap; DGO > 1/4 stylet length.....*Helicotylenchus*
 17'. Dorsal overlap; DGO < 1/4 stylet length.....*Rotylenchus*
 18. One ovary; vulva posterior.....*Pratylenchus*
 18'. Two ovaries; vulva medial.....*Radopholus*
 19. Body white, no cyst, eggs deposited in a matrix;.....*Meloidogynidae*.....*Meloidogyne*
 19'. Body brown hard cyst, most eggs retained;.....*Heteroderidae*.....20
 20. Round cyst.....*Globodera*
 20'. Lemon shaped cyst.....*Heterodera*
 21. With a sheath; Hemicycliophoridae.....*Hemicycliophora*
 21'. Without a sheath.....22
 22. Female posterior swollen, ex. pore posterior; on roots;....*Tylenchulidae*.....*Tylenchulus*
 22'. Female posterior not swollen.....23
 23. Body short, thick; apparent segmentation;*Criconematidae*.....24
 23'. Female small, slender, vulva posterior, no stylet in other stages*Paratylenchus*
 24. Cuticular annulations rounded.....*Mesocriconema*
 24'. Cuticular annulations serrated.....*Criconema*

Source: J.D. Eisenback, *Nematology Laboratory Investigations* (2003)

Objective	Diameter F.O.V.
4x	4.5 mm
10	2.1 mm
20	1.0 mm
40	0.5 mm
100	0.2 mm



A key to a few groups of plant-parasitic nematodes (J.D. Eisenback, after Baudoin).

Pacific Shoot-Gall Nematode *Anguina pacifica* (Cid Del Prado Vera and Maggenti, 1984) (Nematoda: Rhabditida: Anguinidae)¹

Christian Kammerer and William T. Crow²

The Featured Creatures collection provides in-depth profiles of insects, nematodes, arachnids and other organisms relevant to Florida. These profiles are intended for the use of interested laypersons with some knowledge of biology as well as academic audiences.

Introduction

The nematode *Anguina pacifica*, commonly known as the Pacific shoot-gall nematode (Figure 1), is a major pathogen on annual bluegrass (*Poa annua*) in the Pacific region of the United States (McClure et al., 2008; Westerdahl et al., 2004). The family Anguinidae is made up of both fungal feeding nematodes and plant parasitic nematodes. Plant-parasitic genera in the Anguinidae include certain species of *Anguina*, *Subanguina*, and *Ditylenchus*. Unlike most other plant-parasitic nematodes, many species in this family feed on, and cause malformation of, aboveground plant parts (seeds, stems, etc.). Notable turfgrass pests in this group are the root gall nematode (*Subanguina radicola*), the bentgrass nematode (*Anguina agrostis*) and the Pacific shoot-gall nematode *Anguina pacifica*. *Anguina pacifica* feeds on the stem of *Poa annua*, causing stem galls. *Anguina pacifica* is primarily an issue on golf courses where *Poa* is used as a turfgrass for putting greens, primarily in northern coastal California and Ireland. They cause chlorotic and

necrotic spots that coalesce and enlarge over time, creating an inconsistent and unsightly putting surface (Figures 5 and 6).



Figure 1. A second-stage juvenile Pacific Shoot-gall nematode *Anguina pacifica*.

Credits: C. L. Kammerer, University of Florida

1. This document is EENY-785, one of a series of the Entomology and Nematology Department, UF/IFAS Extension. Original publication date April 2022. Visit the EDIS website at <https://edis.ifas.ufl.edu> for the currently supported version of this publication. This document is also available on the Featured Creatures website at <http://entnemdept.ufl.edu/creatures/>.

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Distribution

Anguina pacifica has a limited distribution, favoring damp, cooler climates with temperatures around 12°C to 14°C (53°F to 57°F). *Anguina pacifica* was first reported in northern California in close proximity to the Pacific coast (Cid Del Prado Vera and Maggenti, 1984). Subsequent surveys have found them only in golf courses in a narrow band along California's northern Pacific coast. The first, and so far only, confirmed report of *Anguina pacifica* outside of North America is in Ireland (Fleming et al., 2015). It is believed that *Anguina pacifica* was introduced to Ireland from California on contaminated golf course equipment.

Life Cycle and Biology

The life cycle of *Anguina pacifica* was thoroughly documented by McClure et al. (2008), which is the source for most of the information below. The second-stage juvenile (J2) of *Anguina pacifica* (Figure 1) is the life stage that hatches from the egg and is the infective stage. The J2 crawl up the stem of the bluegrass plant in a film of water; this is thought to be one of the reasons this nematode is prevalent in damp regions. The J2 then enter the leaf sheath, and crawl downward within the sheath to the stem base or crown. Generally multiple nematodes enter a single crown. They enter the crown tissue and manipulate the plant cells in a way that a gall starts to form around them as they feed. Within the gall the nematodes molt into third-stage juveniles, then fourth-stage juveniles, and finally into adults. Because *Anguina pacifica* reproduces sexually by amphimixis, adults are either male or female and both sexes are required for reproduction to occur. While only one male and one female adult would be needed for reproduction, it has been noted that multiple adults of both sexes have been found in a single gall. After mating, the female *Anguina pacifica* (Figure 2) begins laying eggs, usually 1000 or more, within the gall. As the eggs hatch, the gall will contain eggs, juveniles, and adults at the same time (Figure 3). After 36 days or so post infection the females die, leaving eggs and juveniles behind. Around 80 days after infection the gall begins to rot and the J2 leave the gall to search for a new host. As the gall rots, the aboveground portion of the plant dies, causing chlorotic and later necrotic patches on the turf surface (Figure 6). When there is a lack of water, J2 are able to enter an anhydrobiotic state until sufficient moisture is present to resume nematode activity. In anhydrobiosis the nematodes can remain in a state of dormancy for up to 17 months and be readily moved on contaminated equipment.



Figure 2. An adult female *Anguina pacifica* with eggs.
Credits: A. Habteweld, University of Florida

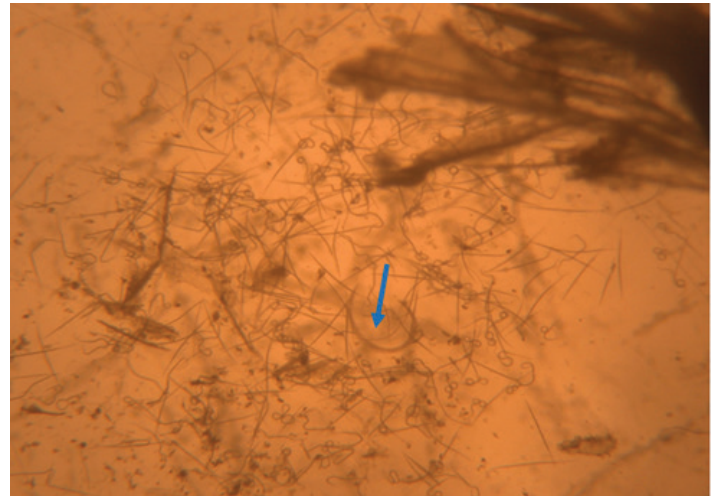


Figure 3. Contents from ruptured *Anguina pacifica* gall including juveniles and adults. The blue arrow points to an adult. All the smaller nematodes present are juveniles.

Credits: C. L. Kammerer, University of Florida

Symptoms and Diagnosis

The major indicator of *Anguina pacifica* on an individual plant is an enlarged crown or gall (Figures 4 and 5). The most characteristic turf symptom of *Anguina pacifica* are yellow patches that vary in size and shape (Figure 6). These patches will eventually become brown in color (Figure 7). Over time these patches coalesce and become larger. These larger patches can culminate in an uneven putting surface caused by a loss of turf (Fleming et al., 2015).

The easiest and most accurate way to diagnose *Anguina pacifica* is to look for stem galls on symptomatic plant tissue, and then mechanically rupture the galls and look for the nematodes within (Figures 3 and 4). For general *Anguina pacifica* assessment, pre-infective J2 can be found in soil and be detected in a typical soil nematode assay. However, for more accurate population density assessment, the [UF Nematode Assay Lab](#) recommends incubating turf plugs using a modified Baermann bowl extraction method.



Figure 4. Visible swelling in the crown of *Poa annua* indicating a gall caused by *Anguina pacificae*.

Credits: C. L. Kammerer, University of Florida



Figure 5. Galls present on cores from *Poa annua* putting greens. Red arrow points to gall on crown.

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Figure 6. Yellow patches characteristic of *Anguina pacificae* on *Poa annua*.

Credits: M. M. Mahady, Mark M. Mahady and Associates, Inc.



Figure 7. With advanced-stage damage caused by *Anguina pacificae* patches become necrotic.

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Hosts

The primary host to *Anguina pacificae* is *Poa annua*, although it can also infect *Agrostus stolonifera* to a lesser extent (McClure et al., 2008; Fleming et al., 2015).

Importance

In coastal California and parts of Ireland, this nematode is the primary nematode concern for turfgrass managers. While *Anguina pacificae* has a very narrow host range made up almost exclusively of *Poa annua*, its effect on annual bluegrass putting greens can be devastating. Where available, nematicides used to manage *Anguina pacificae* are expensive, but revenue losses as golfers choose to play on other courses with better greens are even more costly. Severe infestation can cause golf greens to become unplayable, leading golf courses to renovate and regrass the greens, costing millions of dollars in renovation costs and revenue losses during the renovation process. While *Anguina pacificae* is not known to occur in Florida, its primary host, annual bluegrass, is commonly used as a winter overseed on golf greens in this state. If *Anguina pacificae* became established in Florida it could potentially cause damage to overseeded golf greens under certain conditions, but not likely to the severity as in locations where annual bluegrass is the primary grass year-round.

Morphology

Adult *Anguina pacificae* are roughly 1.4–2.5 mm in length for females and 1.2–1.8 mm in length for males. The body of adults (Figure 8) is much thicker than that of the slender juveniles. A small median bulb is present behind the esophageal lumen which is connected to the feeding part of this nematode, the stylet, but is often difficult to see. *Anguina pacificae* is armed with a slender stylet with knobs and weakly defined cephalic framework (Figure 9). At the rear caudal end of the female, the vulva is situated close

to the tail (Figure 10) (Cid Del Prado Vera and Maggenti, 1984). Annulations are present on the end of the tail (Fleming et al., 2015). These annulations are especially prominent on second stage juveniles. Second-stage juveniles recovered from soil samples are thin, have a small, weak stylet more typical of fungal-feeding than plant-parasitic nematodes, and poorly developed esophageal region (Figure 11).

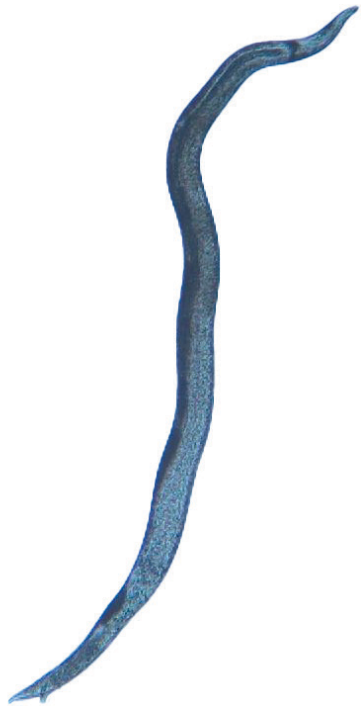


Figure 8. An adult (male) *Anguina pacifica*. The body of the adult is much thicker than that of the juvenile.
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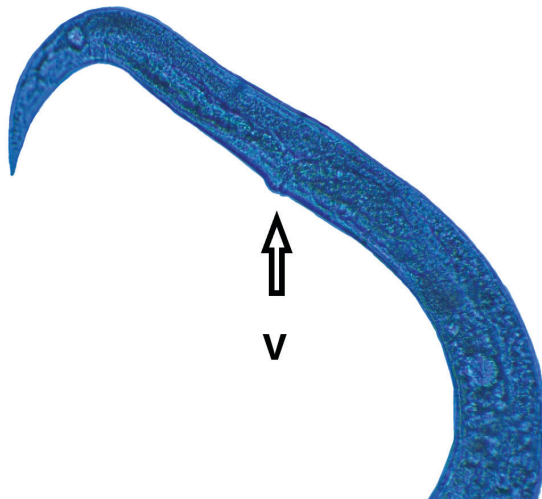


Figure 9. The vulva (V) of the female *Anguina pacifica* is located anteriorly, near the tail (T) of the nematode.
Credits: A. Habteweld, University of Florida

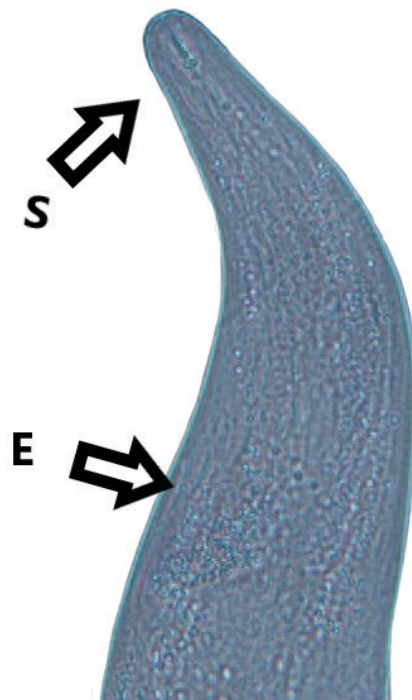


Figure 10. The stylet (S) of *Anguina pacifica* is small and has knobs at the base. Esophageal (E) features lack definition on *Anguina pacifica*.
Credits: C. L. Kammerer, University of Florida

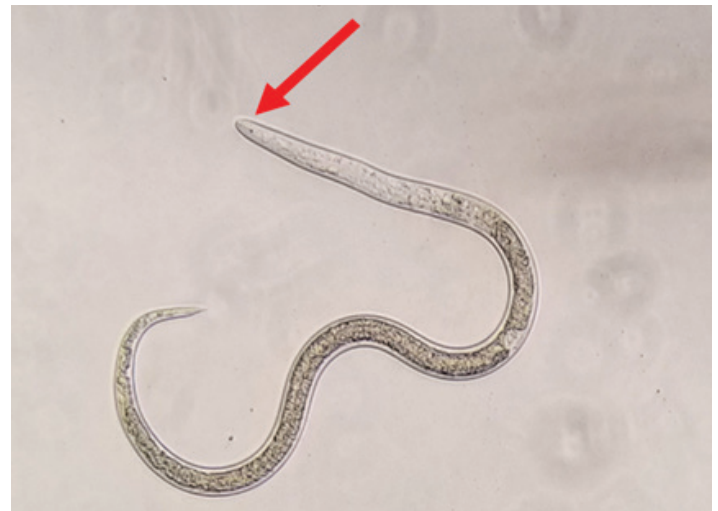


Figure 11. Red arrow pointing to anterior of *Anguina pacifica* juvenile. Note the small stylet with knobs (arrow), and poorly lack of esophageal definition. The juveniles are much slimmer than the adults.
Credits: C. L. Kammerer, University of Florida

Management

As with many other pathogens, the management of this pest includes both cultural practices as well as chemical controls. Due to this nematode's ability to survive without moisture via anhydrobiosis, contaminated equipment poses a serious risk of spreading *Anguina pacifica*. Ensuring that all equipment is properly cleaned prior to use and after use is crucial. Chemical control is an effective method to reduce the low population density of *Anguina pacifica* and to reduce plant damage. Fluopyram (Petelewicz et al., 2020)

and abamectin (Orlinski et al., 2021) have been shown to be effective for managing *Anguina pacifica* and reducing its damage on *Poa* golf greens (Figure 12). The botanical pesticide azadirachtin has shown some activity against *Anguina pacifica* in some trials (McClure and Schmitt, 2012), but not others (Petelewicz et al., 2020). Novel methods of controlling nematodes may also be implemented in the future. White creamy bacteria inside *Anguina pacifica* galls has been inhibiting the developmental cycle of the nematode (McClure et al., 2008).



Figure 12. *Poa annua* green affected by *Anguina pacifica* with fluopyram treated plot showing visible green-up compared to control. Credits: M. M. Mahady, Mark M. Mahady and Associates, Inc.

Resources

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