Population Dynamics and Description of 
Ptycholaimellus hibernus n. sp. 
(Nematoda: Chromadoridae)

RICHARD A. ESKIN and BRUCE E. HOPPER

Abstract: Ptycholaimellus hibernus n. sp. from the muddy subtidal of North Inlet Estuary, Georgetown, South Carolina, is described and a key to the genus is provided. P. hibernus differs from all other species of Ptycholaimellus by the shape of the gubernaculum. Ptycholaimellus sp. 2 Hopper 1969 is synonymized with P. ponticus. The abundance of P. hibernus, measured over a 5-year period, is greatest from January to March, coinciding with minimal annual water temperatures (10-15 C). P. hibernus abundance was significantly (negatively) correlated with water temperature and (positively) with the depth of the anoxic sediment layer.

Key words: ecology, free-living marine nematode, South Carolina, new species, temperature, salinity, taxonomy.

As part of a project to monitor meiofaunal populations in the North Inlet Estuary, Georgetown, South Carolina, population dynamics of nematode species were noted from January 1980 through December 1982. The meiofaunal populations of this area, which is one of the national long-term ecological research sites, have been studied intensively for 10 years (3,4). Few long-term (2 years or longer) investigations of benthic free-living marine nematode populations at the species level have been conducted (1); consequently, little is known about the year-to-year variability in marine nematode populations, although long-term data are available for populations of terrestrial and phytoparasitic nematodes (19,20). This study describes the seasonal population changes of a previously undescribed species of Ptycholaimellus during a 3-year period and the correlation of that population with several physical factors.

MATERIALS AND METHODS

Two replicate cores (2.6 cm i.d.) were taken to the depth of the anoxic sediment layer (as estimated by the presence of a black line; mean depth 2.5 cm) below the level of low tide, at the time of low tide at monthly intervals in 1980 and fortnightly in 1981 and 1982. The cores were fixed in the field with 10% borax buffered formalin, and the organisms were stained with Rose Bengal. Nematodes were extracted from the mud by modified Ludox centrifugal flotation (5) and collected on a 63-µm-pore sieve. The residue was washed into a counting tray and all nematodes were counted under a stereomicroscope; every fourth nematode was removed and mounted in glycerine for identification. The proportion of each species in the aliquot of identified individuals was multiplied by the total number of nematodes in the core and a correction factor to calculate the number of individuals of each species under 10 cm² of surface area. Temperatures were measured at 1-cm depth in the sediment with a mercury thermometer, salinity was measured by refractometer, and the depth of the anoxic sediment layer below the sediment surface (redox potential discontinuity layer) was estimated by the depth of the black line below the surface of the core. SAS software (8) was used for all data manipulation and statistical procedures.

RESULTS

The genus Ptycholaimellus was first proposed by Cobb (2) (type species Ptycholaimellus carinatus Cobb, 1920). Gerlach (6) reduced Ptycholaimellus to a subgenus of Hypodontolaimus. Wieser and Hopper (17) reviewed the genus and noted that in their opinion H. carinatus sensu Timm, 1952 (14) was synonymous with either H. ponticus Fi-
TABLE 1. Measurements of male paratypes of Ptycholaimellus hibernus (summary statistics). Width is the width at the base of the esophagus.

<table>
<thead>
<tr>
<th>Feature</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head width</td>
<td>14</td>
<td>13.4</td>
<td>1.5</td>
<td>10.8–16.2</td>
</tr>
<tr>
<td>Esophagus</td>
<td>14</td>
<td>158.1</td>
<td>7.8</td>
<td>135.0–165.6</td>
</tr>
<tr>
<td>Width</td>
<td>14</td>
<td>48.1</td>
<td>3.5</td>
<td>41.4–54.0</td>
</tr>
<tr>
<td>Maximum width</td>
<td>14</td>
<td>53.2</td>
<td>6.6</td>
<td>41.4–61.2</td>
</tr>
<tr>
<td>ABD</td>
<td>14</td>
<td>36.0</td>
<td>3.3</td>
<td>28.8–41.4</td>
</tr>
<tr>
<td>Tail</td>
<td>14</td>
<td>99.9</td>
<td>12.0</td>
<td>83.0–120.6</td>
</tr>
<tr>
<td>Length</td>
<td>14</td>
<td>930.6</td>
<td>86.8</td>
<td>770.0–1,056.6</td>
</tr>
<tr>
<td>a</td>
<td>13</td>
<td>17.6</td>
<td>2.1</td>
<td>14.3–21.3</td>
</tr>
<tr>
<td>b</td>
<td>14</td>
<td>5.9</td>
<td>0.5</td>
<td>4.9–6.5</td>
</tr>
<tr>
<td>c</td>
<td>14</td>
<td>9.5</td>
<td>1.5</td>
<td>7.0–11.7</td>
</tr>
<tr>
<td>Spicule (l)</td>
<td>9</td>
<td>39.6</td>
<td>2.9</td>
<td>34.2–43.2</td>
</tr>
<tr>
<td>Spicule chord</td>
<td>10</td>
<td>31.7</td>
<td>2.3</td>
<td>27.0–34.2</td>
</tr>
<tr>
<td>Gubernaculum (l)</td>
<td>10</td>
<td>23.7</td>
<td>2.7</td>
<td>19.8–27.0</td>
</tr>
</tbody>
</table>

P. hibernus n. sp.: Eskin, Hopper

Analysis of variance revealed significant
differences ($P < 0.05$) between males and females for all comparable measurements except length ($P = 0.798$) and the ratio $b$ ($P = 0.072$).

*Type locality:* Bread and Butter Creek, North Inlet, Georgetown, South Carolina (33°20′N; 79°10′W). Subtidal fine mud.

P. hibernus n. sp.: Eskin, Hopper 41

4 females, U.S.N.M. #76383–76386. Twelve additional paratypes are retained in the author's collection.

Etymology: (Latin) hibernus for "of winter," because the species abundance is highest at the time of lowest water temperatures in South Carolina.

Differential diagnosis: P. hibernus is most similar to P. pandispiculatus (Hopper, 1961) in general form, but the males are readily distinguished by the morphology of the gubernaculum (Fig. 5a, b). P. hibernus n. sp. has a thick gubernaculum enlarged distally while P. pandispiculatus has a very thin gubernaculum with a proximal apophysis. No character has been found to clearly distinguish the females of these two species, which both occur in our South Carolina site (13). However, P. pandispiculatus seems to prefer brackish water (9; R.A.E., pers.
FIG. 6. Cuticular patterns along body of Ptycholaimellus hibernus (slightly sublateral view). a) Over esophageal bulb. b) Midbody. c) Lateral ala at midbody. d) Tail. (Scale bar applies to a–d.) Note lateral ala is above plane of focus in a, b, and d and sublateral cuticular ornamentation is below plane of focus in c.

obs.) while the type habitat of P. hibernus is a well-mixed estuary with a mean salinity of 35 ppt. Judging from the presence of males, P. pandispiculatus is a rare visitor to the Bread and Butter site. Its frequency is insignificant in comparison to that of P. hibernus n. sp., although it can be common in a high marsh tidal creek and impounded rice paddies in the same estuarine system (13; Coull, unpubl.).

KEY TO THE SPECIES OF Ptycholaimellus

1. Body stout (width ≥ 50 μm), with long (≥ 20 μm) cephalic setae ______ 2

1. Body slimmer (width < 50 μm), cephalic setae less than 10 μm long ______ 3

2. Lateral differentiation begins near head, gubernaculum thin, slightly curved, without lateral processes — P. carinatus Cobb, 1920

2. Lateral differentiation begins mid-esophagus, gubernaculum with proximal lateral processes which lie over spicule — P. slacksmithi (Inglis, 1969)


3. No knob-like swellings at base of tooth, cephalic setae shorter than head diameter ______ 4

4. Protoplasmic interruptions to form double esophageal bulb very weak or absent, no small subventral teeth, small species, L = 650 μm. P. monodon (Schuurmans-Stekhoven, 1942)

4. Double esophageal bulb obvious, small subventral teeth present, larger species, L > 750 ______ 5

5. Length of excretory cell = length of esophagus Ptycholaimellus sp. 2 Hopper, 1969 n. syn. — P. ponticus (Filipjev, 1922)

5. Length of excretory cell < length of esophagus — P. pandispiculatus (Hopper, 1961)

Species no. 2 Hopper, 1969 is synonynous with P. ponticus.

Population: A consistent seasonal population pattern was displayed by P. hibernus n. sp. during the 3 years of this study, with highest populations in January, February, and March and lowest in July, August, and September. The winter highs consistently reached 150–200 animals 10 cm² and the lows usually reached zero (Fig. 7a). When
Fig. 7. Population of Ptycholaimellus hibernus (mean number 10 cm\(^2\) ± 1 standard error) at Bread and Butter Creek. a) From January 1980 to December 1982. b) Mean by month for 3 years (1980–82).

data for 3 years were averaged by month to give an average year, there was a sharp increase in December, followed by a slow increase during January, February, and March and a sharp drop in April (Fig. 7b). Pearson product moment correlations of populations and physical environmental factors were significant for sediment tem-
temperature \((r = -0.68, P = 0.0001)\) and for the depth of the anoxic layer \((r = 0.71, P = 0.0001)\), but not for salinity \((r = -0.19, P = 0.18)\). Temperature and depth of the RPD layer are also significantly correlated \((r = -0.61, P = 0.0031)\), and therefore we cannot determine whether the effects of temperature alone or the potential reduction in habitat caused by the movement of the anoxic, sulfide laden layer toward the surface was responsible for the variation in the nematode population. The ratio of males to females in the population examined was 0.56:1 \((N = 500)\); 47% of all females were gravid. Juveniles composed only 7.4% of the population, suggesting that possibly some were lost during the extraction from the mud and that our absolute population estimates may be low. However, several samples were sieved with both 63- and 44-\(\mu\)m-pore sieves, and the smaller pore size did not collect a significant number of juveniles; therefore, we know they were not passing through our sieve.

**DISCUSSION**

Temperature and the presence or absence of oxic sediment are known to influence reproductive rates, metabolism, abundance, and distribution of marine nematodes \((7,11,16,18)\). Typically such studies have been performed in the laboratory. In the field, temperature can interact in a complex fashion with other physical variables such as the presence of sulfides, the lack of oxygen, and low pH. Our field study has verified such interactions, again confirming the necessity to exercise caution in extrapolating laboratory results to the field.

Diatom abundance data are available for 1981; diatoms are most abundant in March and display a second peak in summer \((12)\). It is possible that the abundance of diatoms in spring provides ample food for rapid growth of nematodes, but in summer detrimental physico-chemical conditions prevent such population growth. Our sampling design did not permit us to determine the cause of the population fluctuations, which may have been caused by die-off followed by recolonization, or by the nematodes going into a resistant stage (perhaps egg) which survived the summer.

The fact that *P. hibernus* is abundant for predictable periods of the year suggests that it may serve as a model organism to experimentally test hypotheses regarding the interaction of nematode life history strategies with environmental factors demonstrated in this study to be important—in particular, the role of the depth of the anoxic layer in determining seasonal abundance and the trophic habits of this species.

**LITERATURE CITED**

16. Warwick, R. M. 1981. The influence of temperature and salinity on energy partitioning in the
Population Densities of *Meloidogyne incognita* and Yield of *Capsicum annuum*¹

**M. Di Vito, N. Greco, and A. Carella**²

*Abstract:* Two microplot experiments in 1981 and 1983 provided information on the effect of different population densities of *Meloidogyne incognita* race 1 and yield of sweet pepper. Microplots were square concrete pipes (30 × 30 cm and 50 cm long) filled with 40 liters of soil infested with 0, 0.062, 0.125, 0.25, 0.5, 1, 2, 4, 8, 16, 32, 64, 128, 256, and 512 eggs and juveniles/cm³ soil. Tolerance limits of 2.2 and 0.165 eggs and juveniles/cm³ soil and minimum yields of 58% and 20% of the controls were obtained in 1981 and 1983, respectively. Maximum reproduction rates of the nematode were 274 and 1,498 at the lowest initial population density. The population of the nematode declined rapidly after harvest, and only 13% and 6.5% of eggs and juveniles were detected in the soil after 1 and 6 months, respectively.

*Key words:* root-knot nematode, tolerance limit, population decline, sweet pepper.

The root-knot nematode *Meloidogyne incognita* (Kofoid & White) Chitwood occurs in almost all vegetable-growing areas of Italy where it suppresses sweet pepper (*Capsicum annuum* L.) yields (2,5). Nematode densities of 0.1 and 1 eggs and juveniles/cm³ soil greatly limit the growth of chile pepper in the United States (6,9). However, information on the effect of various preplant population densities of *M. incognita* on sweet pepper yields is still lacking. Therefore, microplot experiments were performed in southern Italy, in 1981 and 1983, to determine i) the relationship between population densities of *M. incognita* and yield of pepper, ii) reproduction rate of the nematode on pepper at different initial populations, and iii) decline of *M. incognita* population in soil in the absence of plants.

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