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Robert S. Copeland
University of Notre Dame

THE INSECTS OF TREEHOLES OF NORTHERN INDIANA WITH SPECIAL REFERENCE TO *MEGASELIA SCALARIS* (DIPTERA: PHORIDAE) AND *SPILOMYIA LONGICORNIS* (DIPTERA: SYRPHIDAE)

Robert S. Copeland[1,2]

ABSTRACT

The aquatic insect community of treeholes in northern Indiana was surveyed from 1983–1986. Twenty-three species, representing three orders and nine families, were found. *Megaselia scalaris* (Diptera: Phoridae) was collected on several occasions from rotholes, the first member of this family from treeholes. Examination of puparia of *Spilomyia longicornis* (Diptera: Syrphidae) indicated that the larva of this species has been previously described, but incorrectly associated with the genus *Xylota*.

Some plant-associated structures, such as leaf axils and bamboo internodes, are capable of holding enough water to support a macroinvertebrate aquatic community. Most studies of these microhabitats, called phytotelmata (Greek: phyton = plant, telma = pond), have been inspired by their role in the life cycle of certain medically important mosquitoes. Phytotelmata also provide useful ecological models for studying aquatic communities since entire habitats may be sampled and experimentally manipulated.

Treeholes are the most important class of phytotelmata in the holarctic region. During a four year study (1983–1986) of the mosquito community of treeholes in northern Indiana (Copeland 1987), a survey was made of the associated entomofauna, the results of which are presented in this report.

MATERIALS AND METHODS

Study Sites. Three sites were used in this study, all of them in St. Joseph County, Indiana: (1) Horseman's Campground, Potato Creek State Park. This is a 6.3 ha woodlot dominated by American beech *(Fagus grandifolia)* and sugar maple *(Acer saccharum)*. Basal (ground level) and elevated treeholes were sampled at this site. (2) Bendix Woods County Park. This is another beech-maple woodlot. Only basal holes were examined here, as elevated holes were inaccessible for sampling. (3) Urban streets in the towns of South Bend and Notre Dame. Elevated treeholes were found in three maple species; sugar maple, Norway maple *(Acer platanoides)* and silver maple *(Acer saccharinum)*.

Treehole classification. Three treehole classes were recognized in this study; pans,

[1]Vector Biology Laboratory, Department of Biological Sciences, University of Notre Dame, Notre Dame, IN 46556. Reprint requests to Dr. George B. Craig, Jr., Vector Biology Laboratory, Department of Biological Sciences, University of Notre Dame, Notre Dame, IN 46556.

[2]Present address: USAMRU-Kenya, Box 401, APO NY, 09675 or Medical Research Unit, Box 30137, Nairobi, Kenya.

Table 1.—Sources for the identification of non-culicid treehole Insecta.

Order and family	Stage	Reference
Hemiptera		
Pleidae	Adult	Hilsenhoff 1981
Coleoptera		
Helodidae	Larva and adult	Snow 1949
Diptera		
Anisopodidae	Larva	Snow 1949
	Adult	McAlpine et al. 1981
Ceratopogonidae	Adult	Root and Hoffman 1937
		Jamnback 1965
Muscidae	Larva	Teskey 1976
	Adult	Snyder 1955
Phoridae	Adult	W. H. Robinson (pers. comm.)
Psychodidae	Larva	Snow 1949
	Adult	Quate 1955
Syrphidae	Larva	Snow 1949, Maier 1978
	Adult	Williston 1886

shallow rotholes and deep rotholes. The classification is a modification of that of Kitching (1971), and is based on the physical characteristics of the depression and the optical characteristics of the standing water. 'Pans' are water-holding depressions with a complete, unbroken bark lining. They are formed where root buttresses grow together (basal pan) or where a large branch joins the trunk (elevated pan). Pans depend directly on rainfall for their water which is transparent on settling. The range of heights of sampled pans was 0.0 to 10.0 m. Rotholes are actual cavities formed at the site of a wound as the result of fungal and bacterial action. In some cases the wound heals and the cavity is isolated from the vascular system of the tree. These holes, which I call "shallow rotholes" also depend directly on rainfall for their water, which is clear on settling. The height of sampled shallow rotholes ranged from 1.7 to 7.3 m. Other wounds do not heal and filling of these holes depends largely on the movement of liquids in the vascular system of the tree itself. Water from these "deep rotholes" is a dark reddish-brown color due to the presence of dissolved tannins. The water retains this color on settling. The height of sampled deep rotholes ranged from 2.0 to 8.5 m.

Sampling of treeholes. Elevated treeholes above 2.0 m were accessed for sampling by using either a 7.3 m extension ladder or a "High Ranger" truck equipped with an hydraulically driven basket capable of reaching to 10 m.

Small treeholes were emptied with a large syringe. A 1.5 m section of flexible plastic tubing with an inside diameter of 13 mm was used as a siphon to sample larger holes. All holes were refilled with distilled or deionized water and reemptied. Treehole contents were passed successively through a graded series of sieves with diminishing mesh sizes (.84 mm, .42 mm, .14 mm). Sieved larvae, pupae, and detritus were submerged in deionized water in white enameled pans for sorting.

Identification of Insecta. Mosquitoes were identified using the keys of Siverly (1972). Non-culicid larvae were identified to family using the keys in Merritt and Cummins (1984) and Snow (1949), and then to species using the sources listed in Table 1. Whenever possible, individuals were reared to the adult stage in natural treehole water and detritus. Species which leave the water to pupate were provided with access to moist wood chips or bark.

RESULTS AND DISCUSSION

The insect fauna that was collected in this study is listed in Table 2. Twenty-three species were found, representing three orders and nine families.

Megaselia scalaris (Loew) is the first member of the dipteran family Phoridae to be found developing in treeholes. Adults were reared from larvae collected from three deep maple rotholes. Larvae were also found in five other treeholes of this type and a stumphole. The Phoridae are rarely found in aquatic habitats, and Oldroyd (1966) states, "Two things the Phoridae have not managed to do are to take to the water, and to suck blood". However, a few species have been recorded from true aquatic environments, in each case phytotelmata. Phoridae are known from *Nepenthes* pitcher plants in Asia (Thienemann 1932, Schmitz 1932, Schmitz 1955, Beaver 1979), *Sarracenia* pitcher plants in the eastern U.S.A. (Jones 1918) and bromeliads in Brazil (Winder 1977). It is not surprising that the nearly cosmopolitan species *M. scalaris* should exploit treehole water. This species has been recovered from an extraordinary range of microhabitats, including the living and dead immature stages of several insect species, fruit and vegetable matter, boot polish, and milk, and it has also been responsible for human intestinal myiasis (Robinson 1971). *Megaselia scalaris* may be widespread throughout the range of hardwood trees in the eastern United States. Recently, larvae, apparently identical to those of *M. scalaris,* were found in rotholes near East Lansing, MI (E. D. Walker, personal communication).

The larval habitat of the syrphid *Spilomyia longicornis* Loew has been described only recently (Maier 1982). Baker (1938) reported having reared adults of this species and *Spilomyia quadrifasciata* (Say) from treehole larvae but did not associate larval and adult stages. Published descriptions of preadult stages of *Spilomyia* species do not exist. In his monograph on the aquatic Diptera, Johannsen (1935) provisionally placed a larva supplied to him by Baker (1938) in the genus *Xylota*. Apparently, Johannsen was unaware that *Spilomyia* adults had been reared by Baker from treehole syrphid larvae. In his description, Johannsen (1935) refers to ". . . four pairs of bifid and one large pair of trifid curved spines . . ." on the dorsal side of the first visible segment. However, the accompanying illustration (Johannsen 1935, plate IV, figure 45) shows only three pairs of bifid spines. Johannsen's illustration and description, except for the extra pair of bifid spines, correspond exactly to the morphology of third (ultimate) instar larvae of *S. longicornis* that I have reared to adults during the present study. I suggest that Johannsen's (1935) plate IV, figure 45 is an illustration of *S. longicornis* and that his description is either of *S. longicornis* or *S. quadrifasciata,* and not of a species of *Xylota*. All 11 puparia of the *S. longicornis* specimens that I reared had three pairs of bifid spines, in addition to the single pair of trifid spines.

The pleid, *Neoplea striola* (Fieber) was collected on only one occasion, as a 3rd instar nymph from a shallow maple rothole at a height of 4.7 m. This was probably an accidental occurrence, as the Hemiptera have not been recorded previously from treeholes.

Snow (1949) has provided the only comprehensive source of information on insects which develop in water-containing treeholes in the United States. Most of the species he collected were also found during the present study. It is a curiosity of faunal distribution that the Chironomidae and Tipulidae, successful colonizers of nearly all other freshwater habitats including phytotelmata, are absent from wet treeholes in the eastern United States. Representatives of both families are found in treeholes in other geographical areas. Recently, Grodhaus and Rotramel (1980) found chironomids in rotholes in central California, the only report of the occurrence of this family in treeholes in the United States.

Dolichopodidae were conspicuously absent from treeholes sampled in northern Indiana. Snow (1949) found five species in treeholes in the Midwest. However, each was collected rarely, no species being found more than twice, suggesting that these records were accidental occurrences. Alternatively, dolichopodid species may be restricted to particular tree species (these were not indicated by Snow) or 40° N. Lat. (the approximate

Table 2.—The insects collected in treeholes in St. Joseph County, Indiana, 1983–1986.

Order, family and species[a]	Treehole class[b]	Faunal class[c]
Hemiptera		
Pleidae		
Neoplea striola (Fieber)	Shallow rotholes	Dendrolimnetoxene
Coleoptera		
Helodidae		
Cyphon arboricola Snow	Deep rotholes	Dendrolimnetobiont
Helodes fuscipennis Guerin-Meneville	Pans and rotholes	Dendrolimnetobiont
Prionocyphon discoideus (Say)	Deep rotholes	Dendrolimnetobiont
Diptera		
Anisopodidae		
Mycetobia divergens Walker	Deep rotholes	Dendrolimnetophil
Ceratopogonidae		
Culicoides flukei Jones	Deep rotholes	Dendrolimnetobiont
Culicoides guttipennis (Coquillett)	Pans and rotholes	Dendrolimnetophil
Culicoides nanus Root and Hoffman	Deep rotholes	Dendrolimnetobiont
Culicidae		
Aedes hendersoni Cockerell	Pans and rotholes	Dendrolimnetobiont
Aedes triseriatus (Say)	Pans and rotholes	Dendrolimnetobiont
Anopheles barberi Coquillett	Pans and rotholes	Dendrolimnetobiont
Orthopodomyia alba Baker	Deep rotholes	Dendrolimnetobiont
Orthopodomyia signifera (Coquillett)	Rotholes	Dendrolimnetobiont
Muscidae		
Dendrophaonia scabra (Giglio-Tos)	Deep rotholes	Dendrolimnetophil
Phoridae		
Megaselia scalaris (Loew)	Deep rotholes	Dendrolimnetophil
Psychodidae		
Brunnettia nitida (Banks)	Deep rotholes	Dendrolimnetophil
Telmatoscopus albipunctatus (Williston)	Pans and rotholes	Dendrolimnetophil
Telmatoscopus superbus (Banks)	Pans and rotholes	Dendrolimnetobiont
Syrphidae		
Mallota bautius (Walker)	Pans and rotholes	Dendrolimnetobiont
Mallota posticata (Fabricius)	Deep rotholes	Dendrolimnetobiont
Myolepta nigra Loew	Deep rotholes	Dendrolimnetobiont
Myolepta varipes Loew	Deep rotholes	Dendrolimnetobiont
Spilomyia longicornis Loew	Deep rotholes	Dendrolimnetobiont

[a]Members of the Collembolan families Sminthuridae and Poduridae were found in a few rotholes but are not included here because of the uncertainty of the phylogenetic status of this order.
[b]See text for explanation of treehole classification.
[c]After Rohnert (1950). Species are classified according to the level of importance that treeholes assume as habitats for immature stages of the life cycle. Dendrolimnetoxenes occur accidentally in treeholes, dendrolimnetophils exploit treeholes as well as other aquatic habitats, and dendrolimnetobionts are found exclusively in, or largely restricted to, treeholes. Assignment to a faunal class was based on descriptions of larval habitats from the literature and on personal observations.

latitude of the most northern of Snow's dolichopodid collections) may represent the limit of the distribution of nearctic treehole Dolichopodidae.

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