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THE DISTRIBUTION OF FRESH-WATER TRICLAD PLANARIANS IN JEFFERSON COUNTY, OHIO¹

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ABSTRACT²

Seasonal distributions are described for fresh-water triclad planarians throughout the main drainage systems of most of Jefferson County, Ohio. The species found were *Phagocata gracilis gracilis* (Haldeman), *Phagocata morgani* (Stevens and Boring), and *Dugesia tigrina* (Girard). *Dugesia dorocephala* (Woodworth), apparently a common species in the United States, was not found.

Of the species found, *P. g. gracilis* was the most abundant, while *D. tigrina* occurred less abundantly. *P. morgani* was found rarely and only in association with *P. g. gracilis*.

D. tigrina occurred characteristically in lakes and ponds of appreciable temperature ranges. *P. g. gracilis* occurred in cool, fresh springs. Planarians were not found in the large, swift, main streams and were absent from polluted water.

The paucity of studies on the distribution of species and on the ecology of triclad planarians is indicated by Hyman (1951). She points out that such studies east of the Mississippi are few and practically non-existent west of the great river. As far as the midwest is concerned, we found only the work of Kenk (1944) on the triclads of Michigan. Recently, Jenkins and Miller (1962) made a study of the planarian population along Pennington Creek in Oklahoma.

The present work is the result of an intensive study of the occurrence of these flatworms within the confines of a single county. Intensive studies of the population, distribution, and ecology throughout the range of such a widespread group have important aspects which may not be obvious at first consideration. However, the accumulation of such studies may contribute greatly to the development of population genetics, our understanding of speciation, and the implication of ecological factors for both.

The purpose of this study was to determine the distribution of triclad planarians in Jefferson County, Ohio. This survey covered the two main drainage systems in the county, including the main streams and their feeders. In addition to the streams 10 lakes, 3 ponds, 1 river, and 1 strip mine were also investigated. The only water systems that were not studied extensively were the strip mines. The study was limited to natural streams and to artificial lakes.

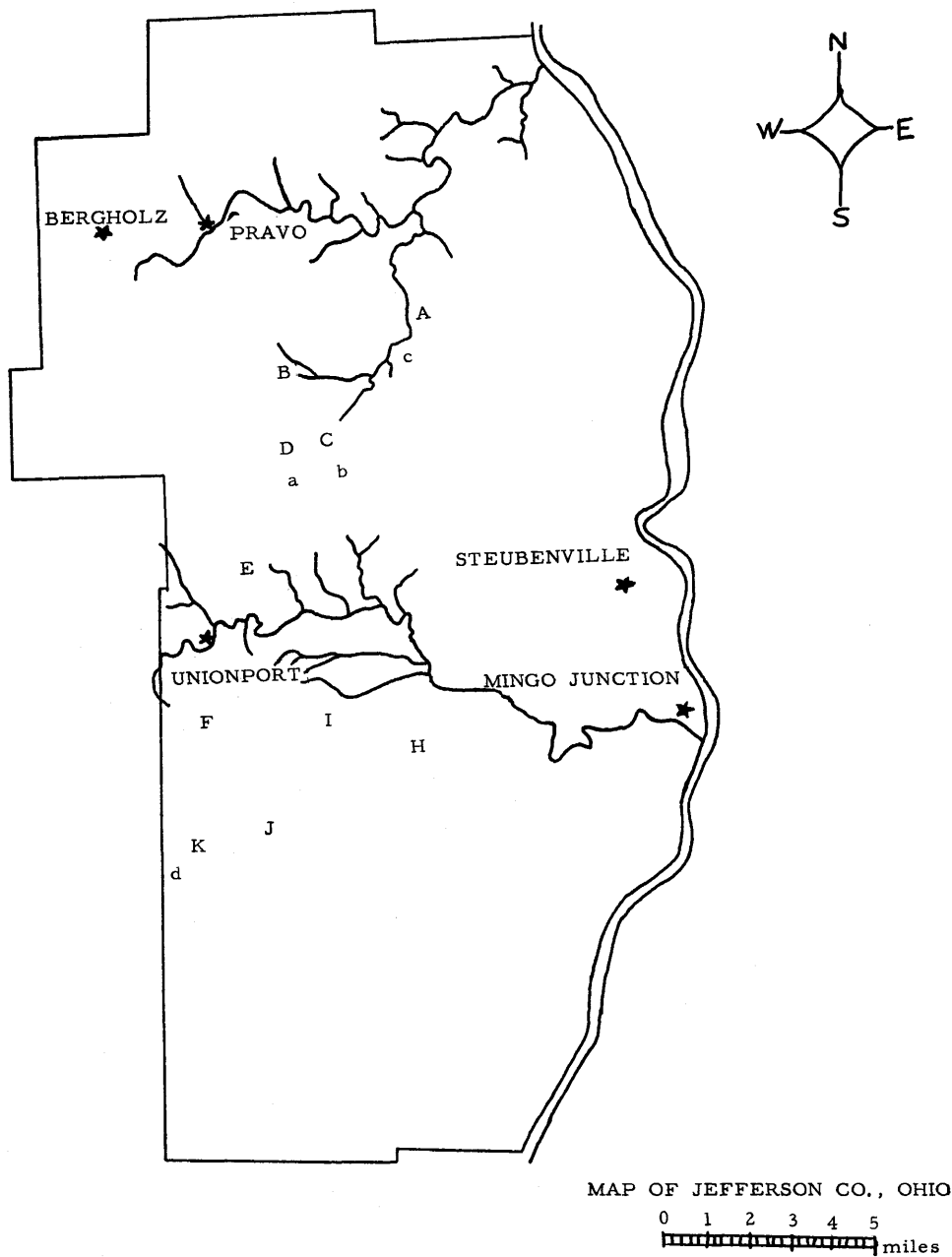
Some attention was given to basic ecological factors such as air and water temperatures, bottom condition, relative water speed and depth, partial chemical analysis of the water, and relative abundance of living organisms. Because of the scope of the project, no attempt was made to classify any organisms, other than planarians, except in broad, general terms.

Jefferson County is located in eastern Ohio and borders on the Ohio River (fig. 1). The study was actually undertaken between 40° 32' and 41° 32' W latitude

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²Prepared by Thomas H. Campbell due to Dr. Stokely's untimely death.

JEFFERSON CO., OHIO



MAP OF JEFFERSON CO., OHIO
 0 1 2 3 4 5
 miles

FIGURE 1. Map of Jefferson County, Ohio, showing the general locations of all the lake and pond stations and the course of Yellow Creek and Cross Creek, the two main streams in the county. The name of each station is as follows: A, Jefferson Lake; B, Austin Lake, C, Shantz's Farm; D, Dye's Lake; E, St. John Vianney Seminary; F, Lake 22; H, Mingo Sportsman's Club; I, Jefferson Sportsman's Club; J, Smithfield Lions Club; K, Pine Valley Sportsman's Club; a, Richmond Riding Stable; b, St. John Fisher's Church; c, Campbell's Frog Pond; and d, Pine Valley strip mines.

and $80^{\circ} 37'$ to $80^{\circ} 52'$ N longitude. This area takes in the northern three quarters of the county.

The locations of the individual stations are as follows:

I. Lakes and Ponds:

Station A, Jefferson Lake, is located in Jefferson State Park in Ross Township, section 18, two miles off state route 43 on county route 54.

Station B, Austin Lake, is in Knox Township, sections 31 and 32, one-half mile from Osage on county route 152.

Station C, Shantz's Farm, is in Salem Township, section 10, one-half mile off state route 43 on county route 152.

Station D, Dye's Farm, is in Salem Township, section 10, two-thirds of a mile west of Richmond off state route 43.

Station E, St. John Vianney Seminary, is in Salem Township, section 19, one-half mile off county route 36.

Station F, Lake 22, is in Wayne Township, section 27, one mile west of Bloomingdale on U. S. route 22.

Station H, Mingo Sportsman's Club, is in Cross Creek Township, section 32, one mile from county route 25.

Station I, Jefferson Sportsman's Club, is in Wayne Township, section 9, one-half mile off county route 25.

Station J, Smithfield Lions Club, is in Smithfield Township, section 24, one-half mile off state route 151.

Station K, Pine Valley Sportsman's Club, is in Smithfield Township, section 36, one mile off county route 10.

Station a, Richmond Riding Stables, is in Salem Township, section 15, two miles off state route 152.

Station b, St. John Fisher (a pond about 100 yards behind the church), is in Salem Township, section 10, one and a half miles off state route 152.

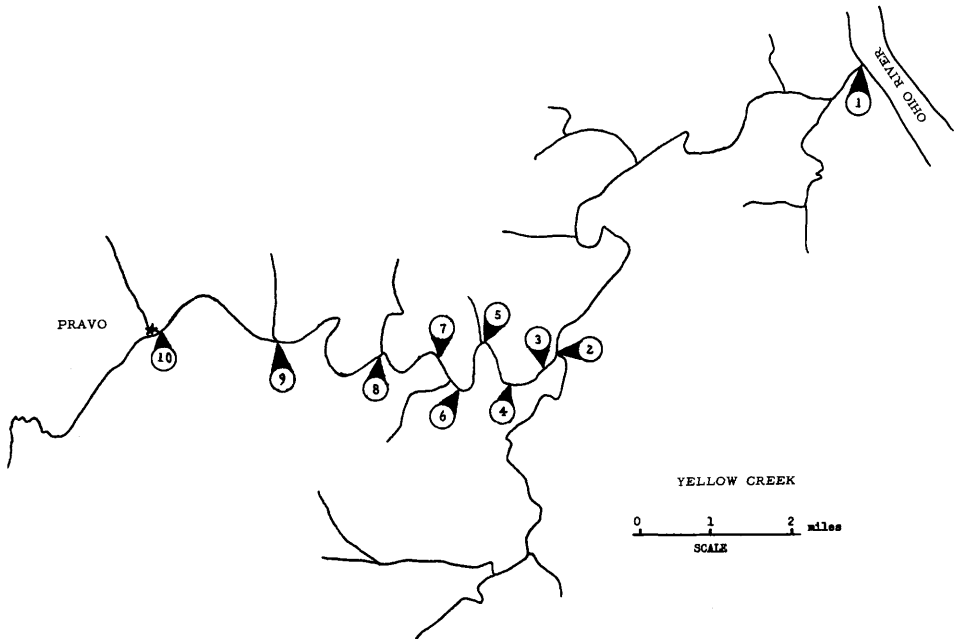


FIGURE 2. Sketch of Yellow Creek showing the location of stations 1 through 10.

Station c, Campbell's Frog Pond (on T. H. Campbell's farm), is located in Knox Township, section 31, 100 yards off county route 56.

Station d, Strip mines, are in Smithfield Township, sections 35 and 36, one mile off county route 10.

II. Stations on Yellow Creek:

Station 1, where creek empties into the Ohio River, is in Saline Township, section 8, about 100 yards from state route 7.

Station 2, where Town Fork Creek enters Yellow Creek, is in Knox Township, section 34, 20 yards from county route 57.

Station 3, 140 yards above point where Town Fork enters Yellow Creek, is in Knox Township, section 34.

Station 4, one-half mile above point where Town Fork Creek enters Yellow Creek (just above Nutter's Dam), is in Knox Township, section 34, 200 yards from county route 57.

Station 5, one and a half miles from county route 57, is in Ross Township, section 4.

Station 6, one-fourth of a mile from the junction of county routes 53 and 57, is in Ross Township, section 3.

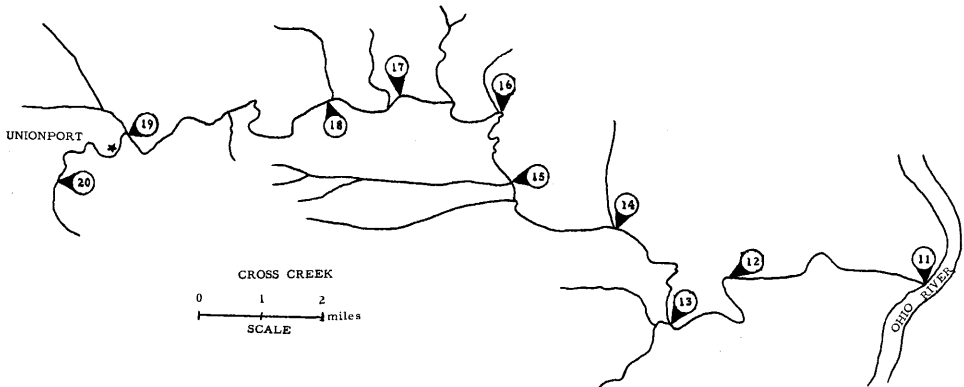


FIGURE 3. Sketch of Cross Creek showing the location of stations 2 through 20.

Station 7, located at the junctions of county routes 53 and 58, is in Ross Township, section 4.

Station 8, where Roach Run enters Yellow Creek, is in Ross Township, section 10.

Station 9, one mile above station 8 where a small feeder enters Yellow Creek, is in Ross Township, section 16.

Station 10, near the bridge on county route 54, is in Ross Township, section 28.

III. Stations on Cross Creek:

Station 11, at point where Cross Creek enters the Ohio River, is in Steubenville Township, section 26, one and a half mile from state route 7.

Station 12, near bridge at junction of county routes 74 and 28, is in Cross Creek Township, section 2.

Station 13, near third bridge on county route 74, is in Cross Creek Township, section 8.

Station 14, one-half mile from Fernwood where a small feeder enters Cross Creek, is in Cross Creek Township, section 21.

Station 15, where a small feeder enters Cross Creek, is in Cross Creek Township, section 34, one and a fourth miles from U. S. route 22.

Station 16, a large feeder at Reeds Mill, is in Cross Creek Township, section 35, one mile from U. S. route 22.

Station 17, main creek one mile from state route 152, is in Wayne Township, section 6.

Station 18, where Salem Creek enters Cross Creek, is in Wayne Township, section 18, three miles from U. S. route 22.

Station 19, one mile from county route 30, is in Wayne Township, section 30.

Station 20, where Cross Creek crosses Jefferson County line, is in Wayne Township, section 34, one mile from county route 30.

The area covered in this study is in very hilly country containing moderately swift-flowing streams. Yellow Creek is 860 ft above sea level at Bergholz and drops to 633 ft where it enters the Ohio. This represents a drop of 227 ft over a distance of 19 miles. Cross Creek is 940 ft above sea level at Unionport and drops to 633 ft where it enters the Ohio. This represents a drop of 307 ft over a distance of 13½ miles. The inland hills average about 1100 ft above sea level and drop to 800 ft very rapidly. Most of the hills have about a 40- to 50-degree slope with a thick covering of the deciduous trees and herbs common to this part of the country.

A large portion of this county has been stripped for coal, perhaps as much as 30 per cent. Both Yellow Creek and Cross Creek pass through strip-mine country and several feeders show visible signs of pollution.

Yellow Creek is about 40 ft wide throughout most of its length. It begins about 13 miles inland and winds its way to the Ohio River. It is fed by two or three large creeks and many small springs. The bottom is very rocky, as might be expected, because, in a stream with such a velocity, silt and pebbles would be carried along. Only in the few variable pools is there a mud bottom. These pools, however, are not very abundant. For most of its length the water is about 10 inches deep. From a point below Pravo, for a distance of about 9 miles, the creek has a bright orange color. This orange color has its source in a few springs that arise from coal tippie washers and mine run-offs. Here no living organisms were found, not even the ever-present crawfish. Above Pravo, the water is not visibly polluted. In this section can be found a variety of microscopic invertebrates, insects, crawfish, and fish.

Throughout the length of Yellow Creek and Cross Creek, there is to be found very little vegetation in the water. The most common plants are diatoms and algae.

The main feeder entering Yellow Creek is Town Fork Creek at station No. 2. At the point where it enters Yellow Creek, it is 8 ft wide and fairly swift. Its current carries it half way out into Yellow Creek. The water of Town Fork Creek is clear and shows no signs of pollution.

The other feeders of Yellow Creek are mainly intermittent, cool, springs of similar swiftness, containing a rich fauna but little vegetation. Most are very clean, but a few are so extremely polluted that nothing is living in them. This is especially noticeable at station No. 8. These springs originate up in small valleys along the main ridges.

Cross Creek is about 35 ft wide throughout most of its length. It begins about 18 miles inland and winds its way to the Ohio River. In many ways, such as size, vegetation, rockiness, and speed, it resembles Yellow Creek. It differs from Yellow Creek in that it has many pools scattered throughout its length. Many of these pools are used by local people as swimming and fishing sites. Although there are no extensive visible signs of pollution, there are at least two known springs which are extremely polluted and discolor the water to a distance of 50 yards from their point of entrance. No living organisms were found in these polluted springs.

On the whole, Cross Creek appears to be swifter and deeper than Yellow Creek. For most of its length the water is about 16 inches deep.

The lakes are all artificial and spring fed, and differ only as to age, size, and community associations. The oldest lake is Jefferson State Lake, Station A, built in the early 1930's. It covers approximately 6 acres and contains a variety of water plants and shore flora. The lake at the present time is becoming very dense with algae.

It also contains a wide variety of game fish and other common lake inhabitants. The lake is surrounded by a dense growth of deciduous trees. The water movement, like in all lakes, is sluggish near the shoreline where all the collecting was done. In the late fall the lake may drop 2 or 3 ft and in spring, after heavy rains, the lake may become extremely muddy. The overflow of this lake is into Town Fork Creek which in turn feeds Austin Lake and eventually ends in Yellow Creek.

Austin Lake, Station B, is more than 5 times the size of Jefferson State Lake, but is several years younger. Although it has a variety of water plants, it as yet is not in any danger of becoming choked with such growth. This lake is widely used as a summer resort.

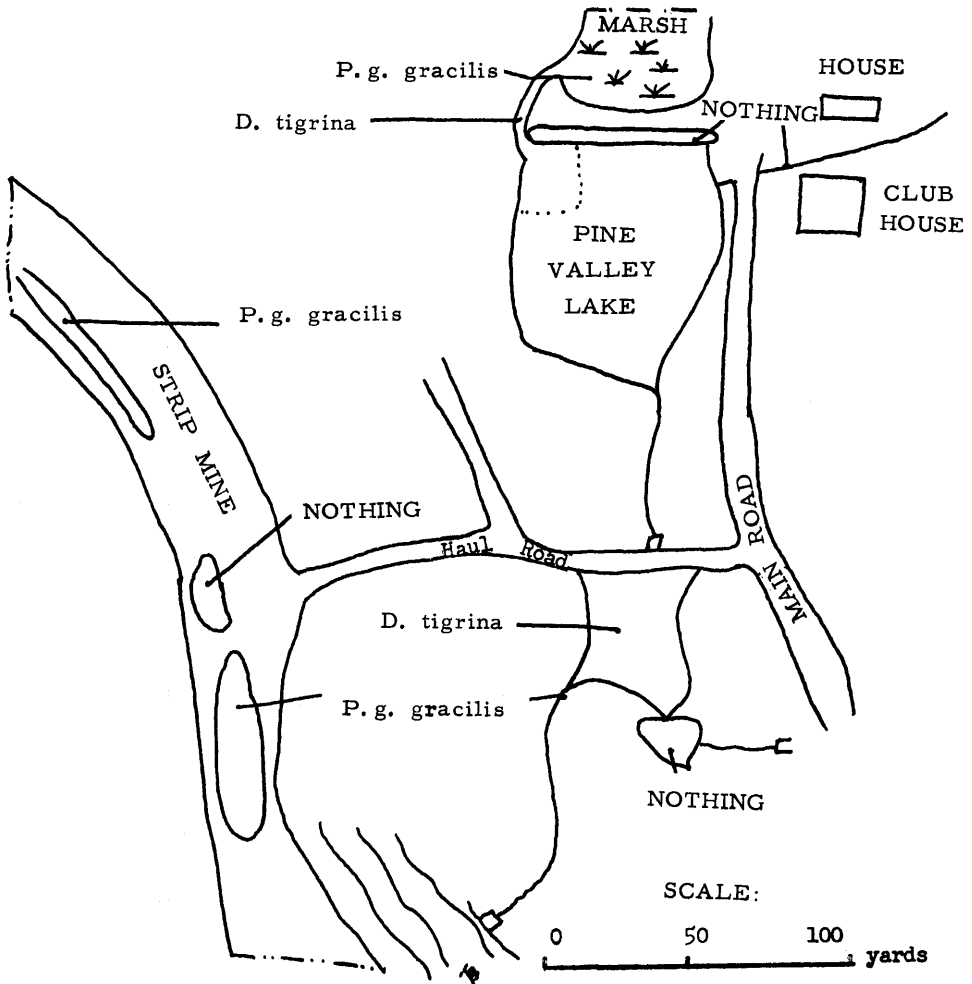


FIGURE 4. Sketch of Pine Valley Sportsman's Club grounds showing main lakes, feeders, and neighboring strip mine ponds, and indicating the species of planaria found in each area.

Several lakes (Jefferson Sportsman's, Mingo Sportsman's, Pine Valley Sportsman's, and Smithfield Lions Club) are all similar with respect to size, depth, vegetation, and bottom condition. These lakes are stocked periodically with a variety of game fish for the enjoyment of the club members.

The remaining lakes are rather small, averaging from a third to an acre or more. They contain the common water plants (algae, cattails), although in such lakes as Lake 22 and St. John Vianney the predominant plants are algae. The lakes serve local fishermen for recreation, but are mostly used for cattle watering.

MATERIALS AND METHODS

Each site studied was given a station designation: creeks, numbers; lakes, capital letters; ponds, small letters. Where a creek was involved, the number refers not only to the point on the creek but also to a feeder entering at, or adjacent to, that point. Each feeder was checked a minimum of 20 yards upstream from its point of entry. The lakes and ponds were each given a station number. This number covers all collecting points around the body of water. The feeders were each examined for a distance of 20 yards upstream from their point of entry and each overflow was checked at least 20 yards downstream from its point of exit.

The presence and abundance of planarians were determined mostly by examining the undersides of submerged rocks and other debris. However, any leaves, twigs, and branches submerged or floating in the water were also examined. If planarians were found, several specimens were collected by brushing them into a bottle with an artist's camel-hair brush. Only enough rocks or other materials were examined to determine the relative abundance. If, after the examination of at least 150 pieces of material, no planarians were found, the site was considered to be planarian-free.

All planarians collected were identified by using the key in Pennak (1953). Minute observations were made with the aid of a lowpower dissecting microscope. Some specimens were preserved and mounted for permanent reference.

Collecting planarians with baited traps is recommended in almost every biology textbook. Our traps, made from bottles, were baited with beef and/or beef liver and were placed in areas where planarians were known to be. Our attempts with this method proved to be fruitless. It is true that these attempts were made to catch *Dugesia tigrina* during October and November when their number begins to diminish.

Samples of water were taken at various stations. Each sample was divided into three parts: one for measurement of pH (determined by a Beckman electric pH meter) and initial dissolved oxygen, one for the determination of the final dissolved oxygen concentration, and the third for the determination of iron and manganese concentrations and turbidity. When the water samples were taken, air and water temperatures, bottom conditions, velocity, depth, visible signs of pollution, and the relative abundance of aquatic flora and fauna were also noted.

The greatest difficulty encountered with respect to terminology was differentiating between "lake" and "pond," and between "creek" and "spring." The lake and pond question was settled rather arbitrarily. If the body of water was large enough to support a population of game fish and appeared to be a permanent structure, it was considered to be a lake; otherwise, the feature was called a pond. As it turned out, such an awkward definition did not prove to be impractical in this particular survey. The biggest pond was Richmond Riding Stable's (Station a) and was only 10 ft in diameter, while the smallest lake, Shantz's farm (Station C), covered more than a third of an acre.

Strictly speaking, each of our creeks, if traced to their origin, could be called a spring. The problem of differentiating between springs and creeks was settled by calling any flowing water under 4 ft wide a spring and all wider streams creeks. Thus, all springs were less than 4 ft, while all creeks in this area are usually 6 ft wide and wider, except, of course, at the point of their origin.

RESULTS AND CONCLUSIONS

From August 1961 to November 1963, approximately 178 points, representing 34 stations, located on various streams, ponds, and lakes throughout three quarters of Jefferson County, Ohio, were checked for triclad planarians. Three species were found: *Phagocata gracilis gracilis* (Haldeman), *Phagocata morgani* (Stevens and Boring), and *Dugesia tigrina* (Girard). Specimens of all three species were found clinging to the undersides of rocks, plants, and other floating and submerged debris.

Kenk (1944) reported that *D. tigrina* inhabited ponds, lakes, rivers, and streams. Hyman (1951) reported that it inhabits streams and ponds. However, in Jefferson County it was found only in sluggish waters such as lakes and ponds (tables 1 and 2). In only two instances in 178 were specimens found outside of a lake. These areas were located in lake spillways when the lakes were frozen (table 1, Stations D and K; and fig. 4).

Approximately 90 per cent of the *D. tigrina* were collected under rocks that were either lying loose on the bottom, or partially buried but having some area exposed to the water. The remaining 10 per cent were found under a variety of materials such as lily pads, logs, beer cans, etc.

Although the lakes in this county vary considerably in age, bottom condition, and community complexity, *D. tigrina* was found in all except one (table 1).

TABLE 1
Planarians in lakes and ponds of Jefferson Co., Ohio

Station	Lake or Pond	Species
A	Jefferson State Lake	<i>Dugesia tigrina</i>
B	Austin Lake	<i>Phagocata g. gracilis</i>
C	Shantz'	<i>D. tigrina</i>
D	Dye's	<i>D. tigrina</i>
E	St. John Vianney	<i>D. tigrina</i>
F	Lake 22	<i>D. tigrina</i>
H	Mingo Sportsman's	<i>D. tigrina</i>
I	Jefferson Sportsman's	none
J	Smithfield Lions Club	<i>D. tigrina</i>
K	Pine Valley Sportsman's	<i>D. tigrina</i>
a	Richmond Riding Stable	none
b	St. John Fisher	none
c	Campbell's Frog Pond	<i>D. tigrina</i>
d	Strip mines	<i>P. g. gracilis</i>

The abundance of *D. tigrina* varies during the year (tables 2, 3 and 6). Individuals begin to appear around the end of February and remain abundant throughout the summer and early fall. Around late October or early November, they become scarce and disappear completely when ice forms. Tables 2 and 3 also afford evidence of their reaction to drought. From July 22 to August 27, 1963, during a period of extensive drought in this county, no *D. tigrina* were found at stations A and F. It was not until the weather cooled and rain fell that the worms again became abundant.

The temperature range *D. tigrina* appears to prefer is between 13 and 25 C. This agrees in general with Dahm (1958), who gives the range as 9 to 25 C in England and Switzerland. Kenk (1944) found *D. tigrina* to be eurythermic in Michigan. The data in tables 2 and 3 agree with this conclusion. The lakes in which *D. tigrina* was found had a maximum-minimum recorded water temperature difference of 28 C. This was recorded at Station A (table 2). The range at this

TABLE 2
*The relative seasonal abundance of D. tigrina
 in Jefferson State Lake*

Date	Temperature C		Relative abundance ¹
	Air	Water	
8/ 9/61	27.0	31.0	***
8/18/61	27.0	31.0	****
8/26/61	21.5	19.5	****
8/31/61	19.6	20.5	****
9/ 7/61	26.0	28.2	***
9/27/61	21.0	24.5	**
10/ 1/61	23.0	20.2	*
11/ 1/61	16.0	13.0	*
11/ 4/61	15.0	13.5	*
11/ 5/61	16.5	13.5	*
11/ 8/61	5.0	9.0	*
11/26/61	13.5	8.3	*
12/ 2/61	9.0	5.5	*
12/17/61	12.0	3.0	frozen
<hr/>			
2/21/63	1.0	2.7	*
3/16/63	4.5	4.0	**
4/ 6/63	20.0	13.0	***
5/18/63	23.0	14.0	***
6/15/63	25.5	15.5	**
7/22/63	28.7	—	0
8 /5/63	32.0	—	0
8/18/63	31.0	—	0
8/27/63	34.0	—	0
9/14/63	27.7	—	****
9/27/63	19.0	17.0	****

¹Abundance estimated according to the number of worms collected in 10 min. * 20 or less; ** 50; *** 100; **** 200 or more.

†No data were gathered during 1962.

lake was 31 C on 9 August to 3.0 C on 17 December, 1961. In comparison, the maximum-minimum temperature difference at Station F (table 3) for the spring inhabited by *P. g. gracilis* was only 14.5 C. The range at this spring was 20 C on 25 August to 5.5 C on 24 November, 1962. Not only did the two habitats differ in their maximum-minimum temperature changes, but the spring underwent less sharp temperature changes.

During a period of sharp weather change, especially in October and November, *D. tigrina* is normally found in aggregates containing from a few up to 200 individuals. These aggregates are composed of individuals lying close to, but not on, each other. Normally more than one aggregate is found on a rock.

Dugesia tigrina, the most common North American fresh-water triclad (Hyman 1951), is not the most abundant in this area, the most abundant species being *P. g. gracilis* (tables 3 and 6). Almost every spring contained them. In many cases, as many as 500 specimens were counted on as few as a dozen 6-inch diameter rocks.

Phagocata g. gracilis was found in aggregates throughout the year, not only during extremely warm weather, as was *D. tigrina*. According to Eddy and Gleim (Hyman 1951), it has been reported that *P. g. gracilis* aggregated at 0 to 10 C, whether taken from its natural habitat at 9.5 C or kept for a month in the laboratory at 20 to 22 C.

Table 3 shows that *P. g. gracilis* is most abundant from November to April. However, even though its number diminishes during the warmer months, it is still more abundant than *D. tigrina*. The springs in which *P. g. gracilis* was found remain cool throughout the greater part of the summer, but are subject to drying up. During the winter, these springs never completely freeze and specimens have been collected during the coldest months (table 3).

TABLE 3
The seasonal occurrence of planarians in Lake 22 and its feeder spring

Date	Area	Temperature C		Species		
		Air	Water	<i>D. tigrina</i>	<i>P. g. gracilis</i>	<i>P. morgani</i>
11/24/62	lake	5.5	7.0	*		
	spring	5.5	5.5		****	*
3/17/63	lake	8.0	8.5	**		
	spring	8.0	6.0		****	*
4/ 7/63	lake	15.0	12.5	**		
	spring	15.0	8.0		****	*
5/ 4/63	lake	20.0	15.0	***		
	spring	20.0	10.0		***	*
6/ 1/63	lake	25.0	17.0	***		
	spring	25.0	12.5		***	*
6/ 8/63	lake	26.5	20.0	**		
	spring	26.5	15.0		***	
7/20/63	lake	30.0	20.5	*		
	spring	30.0	16.5		**	
8/11/63	lake	33.0	25.0			
	spring	33.0	19.5		**	
8/25/63	lake	32.0	25.5			
	spring	32.0	20.0		**	
9/ 6/63	lake	30.5	24.5	**		
	spring	30.5	19.5		**	
11/ 8/63	lake	6.5	9.0	*		
	spring	6.5	7.0		****	*

Phagocata g. gracilis was found in a lake on only one occasion (table 1, Station B), taken in the backwater of Lake Austin where Town Fork Creek enters. At this point the water was several feet deep and moving slowly. This was also the only station where *D. tigrina* and *P. g. gracilis* were found together. Twenty ft above this point, however, Town Fork is swift and no planarians were found. This probably indicates that the condition of the water in Town Fork Creek is not the inhibiting factor. Further on, in the sluggish part of the lake, no *P. g. gracilis* was found. These observations indicate that *P. g. gracilis* prefers a moderately fast stream and does not inhabit either swift or sluggish waters.

Evidence from Station F (table 3), offers a further comparison between *P. g. gracilis* and *D. tigrina*. On all occasions, *D. tigrina* was found only in the lake and *P. g. gracilis* in the spring feeder. *P. g. gracilis* was always more abundant than *D. tigrina*. Table 6 also agrees with the data collected at Station F.

Tables 4 and 5 show that, on both Yellow Creek and Cross Creek, *P. g. gracilis* confined itself to the springs and was not present in the larger main creeks. The reason for this is not known, but it may be related to the current velocity, since the temperature and vegetation do not differ greatly between the two. In many areas of Cross Creek and Yellow Creek there are visible signs of pollution which definitely limit life. However, even where these signs were not visible and a rich fauna existed, no planarians were found.

Although the majority of the springs contained *P. g. gracilis*, five did not.

TABLE 4
The seasonal occurrence of planarians in Cross Creek and its tributary springs

Station	Date	Area	Temperature C		Species
			Air	Water	
11	7/ 8/63	creek	23.0	26.0	
12	7/ 8/63	creek	23.5	26.0	
12	7/10/63	spring	23.5	25.0	
13	7/11/63	creek	24.0	25.0	
16	7/11/63	spring	24.0	24.5	
16	7/11/63	creek	24.5	25.0	
19	7/12/63	creek	23.5	25.0	
20	9/18/63	creek	—	17.0	
18	9/18/63	creek	—	12.0	
18	9/18/63	spring	—	15.0	<i>Phagocata g. gracilis</i>
20	10/11/63	creek	17.0	12.0	
18	10/11/63	spring	17.0	12.0	<i>P. g. gracilis</i>
17	11/ 2/63	creek	2.0	6.0	
16	11/ 2/63	spring	1.5	5.0	<i>P. g. gracilis</i>
15	11/23/63	spring	14.0	10.0	<i>P. g. gracilis</i>
15	11/23/63	creek	14.0	10.0	<i>P. g. gracilis</i>
14	11/23/63	spring	14.0	10.0	
13	11/23/63	creek	14.0	11.0	
12	11/23/63	creek	14.0	11.0	

Except for Station 8, which showed marked signs of pollution, the reasons for this are not known. There were no noticeable differences between these springs and the others.

In comparison with the above species, *Phagocata morgani* is rare. Specimens were found only at Station F (tables 3 and 6) and Station 5 (table 5). At both stations, they were present with *P. g. gracilis*. They were found only in clear and

TABLE 5
The seasonal occurrence of planarians in Yellow Creek and its tributary springs

Station	Date	Area	Temperature C		Species
			Air	Water	
2	8/24/61	spring	—	—	<i>Phagocata g. gracilis</i>
2	11/ 5/61	creek	14.0	12.5	
2	11/17/62	creek	8.5	8.0	<i>P. g. gracilis</i>
3	11/17/62	creek	8.5	7.5	
4	11/17/62	creek	13.0	8.5	
5	11/23/62	creek	5.0	3.5	
5	11/23/62	spring	5.5	6.5	
5	11/23/62	spring	12.0	11.0	<i>P. g. gracilis</i> <i>P. morgani</i>
6	11/23/62	creek	11.0	4.5	
7	11/24/62	creek	3.5	4.5	
8	11/24/62	creek	3.5	5.5	
8	11/24/62	spring	3.5	4.5	
9	11/24/62	creek	3.5	6.5	
9	11/24/62	spring	3.5	6.5	<i>P. g. gracilis</i>
9	11/24/62	spring	5.5	9.0	<i>P. g. gracilis</i>
1	2/ 7/63	creek	-9.0	2.0	
10	2/ 7/63	creek	—	3.0	
10	2/ 7/63	spring	—	3.0	<i>P. g. gracilis</i>

exceptionally cool locations. At Station 5, they were abundant only between the narrow crevices in the sandstone outcropping out of which the spring originated. The data at this point, assuming a narrow temperature spread, agree with the findings of Kenk (1944). Hyman (1951) calls this species an "alpine planarian." At Station F, specimens were found in the spring under rocks along with *P. g. gracilis*. Relatively speaking, *P. morgani* was much more abundant at Station 5 than at Station F. Field observations indicate that this may be because it has more limiting requirements than *P. g. gracilis*.

Dugesia dorocephala (Woodworth), another common triclad planarian in North America (Hyman 1951, Pennak 1953), was not found. In order to be certain of this result, doubtful specimens of *D. tigrina* were compared with positively identified purchased specimens of *D. dorocephala*. In this connection, it is interesting to note that Jenkins and Miller (1962) made a survey of Pennington Creek, Johnston County, Oklahoma, and found only *D. dorocephala*. In comparing the two ecological situations, we found no marked differences between the habitats of the county in Oklahoma and the county in Ohio with regard to pH, temperature, and bottom conditions. We have no data on the concentration of Na, K, and Ca in the local waters, but judging from the distribution of the concentrations of these ions as furnished by Jenkins and Miller (1962), they do not appreciably affect the distribution of *D. dorocephala*. However, Jenkins and Miller's data do show that they found *D. dorocephala* only in streams with moderate to swift currents, never in sluggish waters. In our study we found no planarian in streams with any degree of swiftness. Perhaps the reason we did not find any *D. dorocephala* is the absence of very swift streams.

The water sample data (table 6) are very limited. The table shows that all three species were found in water that was alkaline. The maximum recorded was pH 9.3. At stations 2, 8, and 9, where the pH was acidic (4.5 to 2.7), there were no planarians. Kenk (1944) reported that a low pH was unfavorable for planarians. How low was not stated, nor were we able to ascertain this from our field records. The range of tolerance must be somewhere between 6.6 and 9.3 (table 6). *D. tigrina* was found within a range of 7.5 to 9.0; *P. g. gracilis*, 6.6 to 9.3; and *P. morgani*, 8.1 to 8.7.

The range of initial dissolved oxygen (IOD) for *D. tigrina* was 5.5 to 15, and the final dissolved oxygen (FOD) range, 1.6 to 13. For *P. g. gracilis* the IOD range was 5.4 to 10.4 and the FOD range, 4.9 to 8.5. For *P. morgani* the IOD range was 9.6 to 10.4 and the FOD range, 4.9 to 8.4.

A study of table 6 indicates that, from our data, we cannot infer any appreciable effect on distribution of these three species by the available oxygen within the values given above. We can safely conclude, however, that all three species prefer an alkaline medium. With regard to temperature, *D. tigrina* has the broadest range of tolerance and *P. morgani* the least. Both *P. g. gracilis* and *P. morgani* require cooler waters than *D. tigrina*.

SUMMARY

1. A study was made to determine the distribution and basic ecological factors of fresh-water triclad planarians at 34 stations in Jefferson County, Ohio. Only three species of planaria were found: *Phagocata gracilis gracilis* (Haldeman), *Phagocata morgani* (Stevens and Boring), and *Dugesia tigrina* (Girard). *Dugesia dorocephala* (Woodworth), although a common fresh-water triclad in the U. S., was not found in this county.

2. *Dugesia tigrina* was found only in lakes and ponds. These were areas of wide temperature ranges. The maximum difference recorded was 28 C. Individuals of this species were most abundant, however, in water at temperatures between 13 and 25 C. In the early spring and late fall *D. tigrina* is normally found in aggregates. It disappears from the lakes soon after the formation of ice.

TABLE 6
The seasonal occurrence of planarians together with some physical and chemical factors in the medium

Station	Date	Habitat	Species	Relative abundance	Temp. C water	pH	Turb. mg/liter	IOD*	BOD**	FOD***	Fe ppm	Mn ppm
A	9/29/63	lake	<i>D. tigrina</i>	***	17.0	8.0	2.75	11.0	2.7	8.3	0.1	0.1
B	9/29/63	lake	<i>D. tigrina</i>	*	17.5	7.5	26.50	—	—	—	0.3	0.1
			<i>P. g. gracilis</i>	*								
C	9/29/63	lake	<i>D. tigrina</i>	*	18.0	8.2	14.00	10.0	3.4	6.6	0.0	0.1
E	10/11/63	lake	<i>D. tigrina</i>	***	14.0	8.0	3.60	5.5	3.9	1.6	1.0	1.0
F	11/ 8/63	lake	<i>D. tigrina</i>	**	9.5	9.0	12.00	15.0	1.9	13.1	0.1	0.0
F	11/ 8/63	spring	<i>P. g. gracilis</i>	****	8.5	8.7	6.80	10.4	5.5	4.9	—	0.0
			<i>P. morgani</i>	*								
H	11/ 8/63	lake	<i>D. tigrina</i>	*	8.0	7.5	6.80	8.8	2.3	6.5	0.1	0.3
I	11/ 8/63	lake			9.5	8.0	7.60	10.2	1.3	8.9	—	—
J	10/26/63	lake	<i>D. tigrina</i>	***	18.0	8.5	14.00	7.8	1.8	6.0	0.1	0.1
K	11/ 8/63	spring	<i>P. g. gracilis</i>	***	9.5	8.1	26.00	9.6	1.2	8.4	0.1	0.0
2	9/29/63	creek			12.7	3.2	6.3	9.8	0.8	9.0	5.0	3.0
2	9/29/63	spring	<i>P. g. gracilis</i>	*	14.0	6.6	1.1	5.4	1.4	4.0	0.0	0.0
8	9/29/63	spring			12.5	2.7	2.3	0.2	0.0	0.0	9000	0.0
9	9/29/63	spring			13.0	4.5	12.3	8.2	3.2	5.0	0.2	6.0
10	9/29/63	creek			14.0	6.4	3.6	8.4	1.9	6.5	0.1	0.1
12	11/23/63	creek			11.0	9.8	0.5	—	—	7.6	0.0	0.1
13	11/23/63	creek			11.0	9.6	0.6	—	—	8.8	0.0	0.0
14	11/23/63	spring			10.0	9.6	0.7	—	—	8.7	0.0	0.0
15	11/23/63	creek	<i>P. g. gracilis</i>	*	11.0	9.3	2.25	—	—	8.5	0.1	0.0
15	11/23/63	spring	<i>P. g. gracilis</i>	***	10.0	8.4	1.25	—	—	7.3	0.0	0.1
16	11/ 2/63	spring	<i>P. g. gracilis</i>	***	5.0	8.1	1.1	10.4	—	—	0.0	0.0
17	11/ 2/63	creek			6.0	8.4	4.2	10.1	—	—	0.1	0.0
18	10/11/63	spring	<i>P. g. gracilis</i>	**	12.0	8.3	7.2	9.5	1.3	8.2	0.0	0.0
20	10/11/63	creek			12.0	8.4	1.2	8.8	3.7	5.1	0.0	0.1

*IOD, initial dissolved oxygen; **BOD, bacterial oxygen demand; ***FOD, final dissolved oxygen.

It reappears again in February and March and remains abundant throughout the summer. In the late fall it again becomes scarce.

3. *Phagocata gracilis gracilis* was found only in cool fresh springs that were relatively slow moving and free of pollution. Heavily polluted streams fed by coal tippie washers and mine runoffs contained no visible animal life. *Phagocata g. gracilis*, which inhabits cool springs, aggregates throughout most of the year, the exception being only during extremely warm weather. It is most abundant from November to April.

4. *Dugesia tigrina* and *Phagocata gracilis gracilis* were abundant in alkaline water. The highest pH recorded was 9.0.

5. *Phagocata morgani* was found in exceptionally pure and cool springs and was generally scarce.

6. No planarians were found in the large, swift main creeks.

7. The most abundant species of triclad planarians in Jefferson County was *Phagocata gracilis gracilis*.

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