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DRAGONFLIES AND DAMSELFLIES (ODONATA) OF THE GRAND RIVER SYSTEM, NORTHEASTERN OHIO, 1974-1978[1]

T. E. PERRY, Chagrin River Road, Gates Mills OH 44040

Abstract. Fifty-three collecting stations were established on the Grand River system, Northeastern Ohio, including tributary streams and watershed, from 1974 through 1978. Dragonfly and damselfly adults, nymphs, and exuviae were collected and counted, resulting in 77 species taken. Populations were measured and plotted as to habitat and time. Selected chemical and physical data were measured and a base-line was established for further work on the subject. I identified 6 habitat-areas of the river proper, which yielded distinctive, diverse kinds of Odonata: *Boyeria-Calopteryx-Cordulegaster* (tributary streams), *Calopteryx-Hagenius-Nasiaeschna* (upper river), *Basiaeschna-Didymops-Dromogomphus* (transition area), *Argia-Gomphus-Hetaerina* were the major genera found at the middle portion of the river, and *Argia-Enallagma-Libellula* at the lower portion near the mouth. Lakes and ponds studied in the watershed contained mainly *Aeshna-Enallagma-Libellula.*

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One major aim of this study was to establish a base-line for future studies of dragon and damsel flies, since it would be of interest to know how much change in odonate populations takes place over the years, and to what degree some of the environmental parameters may be altered. Another purpose was to find specifically how Grand River odonates were distributed in space and time in the varied habitats represented.

PHYSICAL GEOGRAPHY OF THE STUDY AREA

The Grand River's main channel may be physiographically divided into 4 distinct areas. Origin of the river is a swampy wooded tract in southern Geauga County near Parkman, Ohio. The upper river flows placidly, sluggishly in a series of meanders through the flat to gently rolling farmlands of Trumbull and Ashtabula Counties. The upper river is shallow and turbid, with a width of 3 m to 15 m. The transition area, from Harpersfield to Mechanicsville, by contrast, is deep, trench-like, wide in places, caused by damming. The most scenic part of the Grand is the middle channel, from Harpersfield to suburban Painesville, where the river, flowing from east to west, has cut a deep channel into a shaley escarpment. The lower river and mouth, from Painesville to Lake Erie, tend toward a deep channel and flood plain with swampy tracts surrounding. Tributary streams vary but tend to be shallow with bottom materials ranging from sand to solid rock, with picturesque riffles and waterfalls.

The watershed of the Grand River is well-vegetated, due in part to sparse human settlement. Land usage is agricultural and recreational (fig. 1).

The Grand River, in shape of a backward C, flows eastward from its origins, then northward, then westward, and after 155 km (96 miles) empties into Lake Erie at Fairport Harbor, Ohio. It drains an area of about 2072 km^2 (800 miles^2), with an average gradient of about 4.5 ft/mile. According to White (1951), the north-south, upper portion of the Grand was joined to a section of the Cuyahoga River, whose headwaters lie near the Grand's origins. The Cuyahoga, during the glacial era, was joined to the Tuscarawas River as part of Ohio River drainage. The east-west (middle and lower) portions of the Grand were formed later and caused the

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older (upper) part to reverse flow into Lake Erie.

METHODS AND MATERIALS

Fifty-three collecting stations were established along the Grand River, its tributaries, and at selected lakes and ponds within its watershed. Activities included collecting adults, nymphs, and exuviae; population counts and estimations; sightings of identifiable species; observations of pairing and oviposition; and water testing. Activities took place April through November 1974 through 1978. Depending upon their productivity, sites were visited on an average of once to as many as eight times per month.

Materials used included long handled aerial insect nets, aquatic D-frame and regular dip nets, and the usual killing and preserving equipment (cyanide and isopropyl alcohol). We also used a water sampler of our own construction, a LaMotte water test kit, and an aluminum jon boat.

RESULTS

Our primary thrust was collection of adults (77 species taken); nymphs, exuviae, and emergents were collected for 21 species. Oviposition was observed for 15 species, and pairing at presumed breeding-site observed for 28 species. Adults for 76 species are represented in the author's collection; the 77th, *Anax longipes*, is represented by 3 exuviae. We took 390 adult individual insects (see table 1).

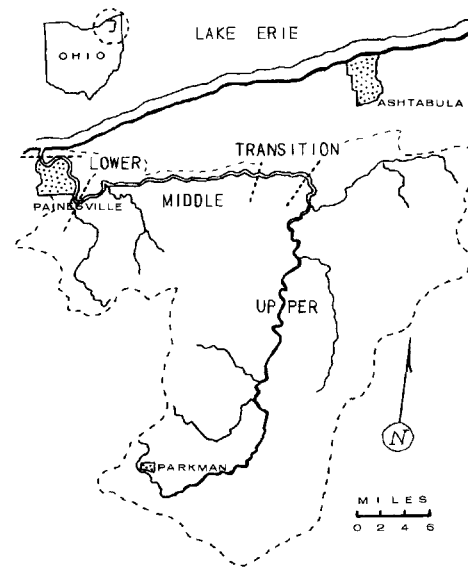

FIGURE 1. Map of the Grand River and its watershed showing major subdivisions.

TABLE 1

Habitat and temporal distribution of Odonata collected and observed in the Grand River watershed 1974–1978.

Suborder/Family: species	Habitat Distribution†					Temporal Distribution			
	LPM	Low	Mid	Tn	UpTr	M–J	July	Aug	S–O
Anisoptera/Petaluridae:									
Tachopteryx thoreyi	—	—	—	—	6	6	—	—	—
Anisoptera/Cordulegastridae:									
Cordulegaster diastatops	—	—	—	—	1	—	1	—	—
Cordulegaster maculata	—	—	—	—	20	20	—	—	—
Cordulegaster obliquus	—	—	—	—	1	1	—	—	—
Anisoptera/Gomphidae:									
Dromogomphus spinosus	2	—	71	42	5	35	80	5	—
Gomphus exilis	57	—	—	3	3	61	2	—	—
Gomphus fraternus	—	—	21	—	19	38	2	—	—
Gomphus lineatifrons	—	—	45	—	—	44	1	—	—
Gomphus lividus	—	—	—	—	89	89	—	—	—
Gomphus quadricolor	—	—	19	—	—	19	—	—	—
Gomphus villosipes	19	—	—	—	4	23	—	—	—
Gomphus viridifrons	—	—	1	—	—	1	—	—	—
Hagenius brevistylus	—	—	—	—	10	4	6	—	—
Lanthus albistylus	—	—	13	—	5	17	1	—	—
Ophiogomphus rupinsulensis	—	—	57	—	—	56	1	—	—
Anisoptera/Aeshnidae:									
Aeshna constricta	6	—	—	—	—	—	—	—	6
Aeshna tuberculifera	5	—	—	—	—	—	1	—	4
Aeshna umbrosa	42	—	—	—	—	—	—	7	35
Anax junius	68	—	—	1	—	28	26	11	4
Anax longipes	3	—	—	—	—	—	2	1	—
Basiaeschna janata	2	—	—	3	13	18	—	—	—
Boyeria grafiana	—	—	—	—	23	1	—	16	6

TABLE 1. *Continued.*

Suborder/Family: species	Habitat Distribution†					Temporal Distribution			
	LPM	Low	Mid	Tn	UpTr	M–J	July	Aug	S–O
Boyeria vinosa	—	—	4	—	5	—	3	5	1
Epiaeschna heros	—	—	1	—	—	1	—	—	—
Nasiaeschna pentacantha	—	—	—	—	14	14	—	—	—
Anisoptera/Macromiidae:									
Didymops transversa	—	—	4	15	5	24	—	—	—
Macromia illinoiensis	—	—	29	—	11	20	28	2	—
Anisoptera/Corduliidae:									
Epitheca canis	—	—	—	—	1	1	—	—	—
Epitheca cynosura	6	—	—	3	1	63	7	—	—
Epitheca princeps	38	—	—	6	—	28	14	1	1
Anisoptera/Libellulidae:									
Celithemis elisa	24	—	—	1	—	4	8	10	3
Celithemis eponina	17	—	—	—	—	—	7	—	—
Leucorrhinia intacta	87	—	—	—	3	79	11	—	—
Libellula luctuosa	169	—	2	25	—	32	70	68	26
Libellula pulchella	87	—	—	—	—	69	11	4	3
Mesothemis simplicicollis	77	—	—	6	—	33	33	16	1
Pachydiplax longipennis	32	—	—	5	—	34	3	—	—
Pantala flavescens	11	—	—	—	—	—	1	8	2
Pantala hymenaea	4	—	—	—	—	—	1	3	—
Perithemis tenera	104	—	12	8	—	9	68	24	23
Plathemis lydia	117	1	—	30	—	99	83	37	12
Sympetrum rubicundulum	32	—	—	—	—	—	14	18	—
Sympetrum semicinctum	15	—	—	—	—	—	—	15	—
Sympetrum vicinum	142	—	—	4	—	—	—	3	143
Tramea lacerata	14	—	—	1	—	3	10	—	2
Zygoptera/Agrionidae:									
Calopteryx maculata	—	—	11	—	172	90	71	22	—
Hetaerina americana	—	—	75	—	—	6	55	13	—
Zygoptera/Lestidae:									
Lestes congener	46	—	—	—	—	—	—	11	35
Lestes disjunctus australis	1	—	—	—	—	1	—	—	—
Lestes eurinus	21	—	—	—	—	5	16	—	—
Lestes inaequalis	8	—	—	—	—	8	—	—	—
Lestes rectangularis	9	—	—	30	—	4	29	6	—
Lestes vigilax	39	—	1	—	—	—	9	20	11
Zygoptera/Coenagrionidae:									
Amphiagrion saucium	—	—	—	—	15	15	—	—	—
Argia apicalis	38	—	53	1	—	1	79	12	—
Argia moesta	—	26	208	—	34	85	175	7	1
Argia sedula	—	—	138	—	—	—	132	6	—
Argia tibialis	—	—	3	—	95	31	62	5	—
Argia translata	—	2	17	—	—	—	17	2	—
Argia violacea	52	1	41	4	5	8	60	35	—
Chromagrion conditum	10	—	—	—	11	21	—	—	—
Coenagrion resolutum	1	—	—	—	—	1	—	—	—
Enallagma antennatum	32	—	—	14	13	40	19	—	—
Enallagma aspersum	68	—	—	—	—	25	33	2	8
Enallagma basidens	29	—	—	1	—	3	11	11	5
Enallagma carunculatum	2	—	—	1	—	—	—	2	1
Enallagma civile	184	—	—	25	—	16	13	174	6
Enallagma cyathigerum	2	—	—	—	—	2	—	—	—
Enallagma ebrium	5	—	—	—	—	1	4	—	—
Enallagma exsulans	1	—	245	—	15	99	152	10	—
Enallagma geminatum	17	—	—	5	—	6	6	1	9
Enallagma signatum	121	—	—	2	—	1	30	52	40
Enallagma traviatum	26	—	—	—	—	10	16	—	—
Enallagma vesperum	2	—	—	—	—	—	1	1	—
Ischnura posita	101	—	—	36	—	38	61	28	10
Ischnura verticalis	220	12	3	17	2	82	65	71	36
Nehalennia irene	1	—	—	1	—	1	1	—	—

†LPM = Lake-Pond-Mouth of river, Low = Lower river, Mid = Middle section of river, Tn = Transition portion of river, UpTr = Upper part of river and tributaries.

Population distribution of odonate families represented in the 7 major habitats of the Grand River is shown in figure 2. Major habitat strongholds, along with diversity and number of individual dragonflies within their families may be derived from figure 2. Most productive areas were lake-pond and middle river; most diverse were tributary and upper river in terms of number families represented. Lower river and river mouth habitats appeared the least productive and the least diverse.

The total number of species for each habitat-area was compared with each other habitat-area according to the diversity index formula adapted from Phillips (1959):

$$DI = 2\ S_{ab} / S_a + S_b \times 100$$

where S_{ab} represents number of species common to both habitat-areas being compared, and $S_a + S_b$ represents the total number of species in the 2 habitats. A diversity index results in a scale of 0 (completely dissimilar) to 100 (com-

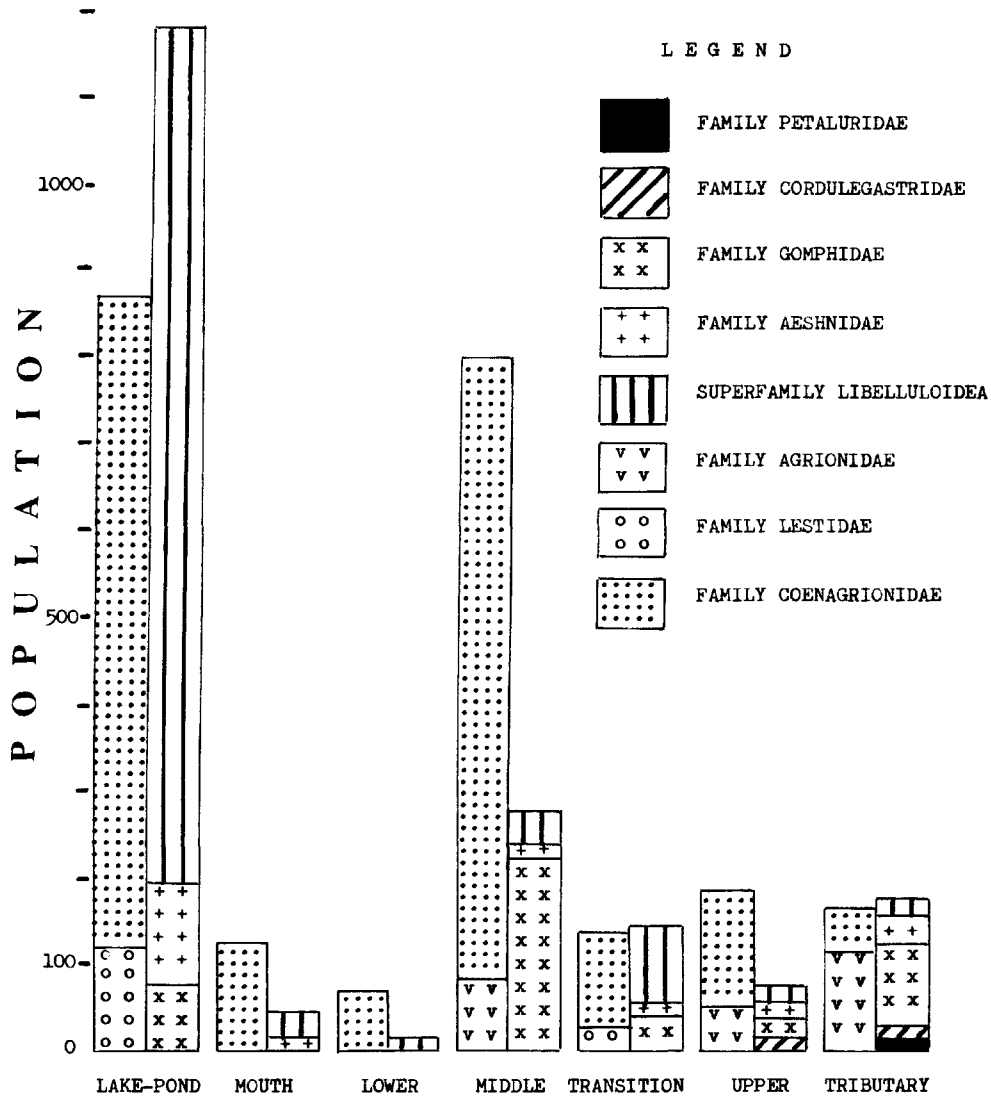

FIGURE 2. Population of individual Odonata by family in each Grand River habitat, 1974–1978.

pletely similar). Results of this index are shown in table 2 and indicate how diverse most of the habitat-areas were in terms of dragonfly species present

TABLE 2
Diversity indices† comparing Grand River habitats, 1974–1978.

	Habitat*					
	L-P	M	Low	Mid	Tran	Up
Mouth	38	—	—	—	—	—
Lower	11	20	—	—	—	—
Mid.	14	06	37	—	—	—
Transition	62	44	19	25	—	—
Upper	15	00	18	18	23	—
Tributary	19	06	21	37	24	53

†100=completely similar; 00=completely dissimilar.
*L-P=Lake Pond, M=mouth, Low=Lower river, Mid=Middle section of river, Tran=Transition portion of river, Up=Upper portion of river.

and absent. The only areas that approached being comparable were lake-pond and transition (index of 62) and tributary and upper (index of 53). The transition area tended to be pond-like, and tributary streams were somewhat comparable to the upper river in terms of channel depth, and to a lesser extent in terms of water velocity and substrate.

Physical, chemical, and selected biological characteristics of Grand River habitat-areas are given in table 3. Chemical conditions throughout the river tended to be somewhat more uniform than physical conditions.

Changes in river water-level had pronounced effects upon adult dragonfly populations. Late one spring (1977), a drought resulted in low water and an abundance of lotic species, mostly gomphines, appeared on river. A slight rise in water-level, on the other hand, often resulted in movement away from river. Also during 1977 we began to find *Dromogomphus spinosus*, typical riverine species, at pond sites several kilometers from the Grand.

No single species was universally found on the entire river. Members of the genus *Argia*, however, were taken at all habitats, even the more heavily polluted downstream ones. *Enallagma*, another damselfly genus, was also present in all habitat-areas. The number of species of Odonata found in all habitats is indicated in table 4, from which it can also be noted that upstream locations (middle, tributary, upper) were favored by the families: Petaluridae, Cordulegastridae, Gomphidae. Downstream locations (lower, mouth) tended to be

TABLE 3
Characteristics of Grand River habitats.

Characteristic	Habitat†					
	L-P	L-M	Mid	Tran	Up	Trib
Width (m)	varies	15–140	15–76	15–212	3–15	0.3–3
Depth (m)	to 3.6	0.3–7	0.15–1.8	0.2–3	0.2–1	0.1–0.9
Velocity (cm/sec)	none	negligible	9–81	negligible	negligible	8–76
Substrate	silt	silt to rubble	sand to boulders	mostly fine	sand	sand to boulders
Oxygen (ppm)	9.7	8.6	10.0	6.2	10.0	12.7
Carbon dioxide (ppm)	4.0	5.5	5.5	6.5	6.5	5.5
Calcium (ppm)	25.0	105.0	50.0	30.0	40.0	65.0
Magnesium (ppm)	175.0	95.0	50.0	80.0	70.0	55.0
Nitrate (ppm)	0.0	0.0	0.0	0.0	0.9	0.9
Phosphate (ppm)	0.0	0.0	0.0	0.0	0.0	0.0
Silica (ppm)	0.5	3.0	2.5	2.5	3.0	6.0
pH	7.5	7.5	7.5	7.5	7.5	7.5
Predominant fish	bass, bluegill	perch	bass, sucker	muskel-lunge, pike	varies	minnows

†L-P=Lake-Pond, L-M=Lower river and mouth, Mid=Middle section of river, Tran=Transition portion of river, Up=Upper portion of triver, Trib=Tributary streams.

populated by Libellulids and Coenagrionids, much like lakes and ponds within the watershed.

TABLE 4

Number of species of Odonata by family in each Grand River habitat, 1974–1978.

Family	Habitat* and Number Species						
	L-P	M	Low	Mid	Tran	Up	Trib
Petaluridae	—	—	—	—	—	—	1
Cordulegastridae	—	—	—	—	—	1	2
Gomphidae	2	—	—	7	2	4	5
Aeshnidae	7	1	—	1	2	3	4
Macromiidae	—	—	—	2	1	2	2
Corduliidae	2	—	—	—	2	—	1
Libellulidae	14	8	1	1	7	—	—
Agrionidae	—	—	—	2	—	1	1
Lestidae	6	—	—	—	1	—	—
Coenagrionidae	18	4	5	8	11	4	6

*L–P=Lake Pond, M=mouth, Low=Lower river, Mid=Middle section of river, Tran=Transition portion of river, Up=Upper portion of river, Trib=Tributary streams.

DISCUSSION

It was interesting to compare our results with those of writers who studied lotic Ohio dragonflies earlier and from different parts of the state. Kellicott's turn-of-the-century study (1899) considered certain species common that in our study were occasional or rare for this part of Ohio: *Aeshna constricta*, *Didymops transversa*, and *Hagenius brevistylus*. Osburn and Hine (1900) took many of the same species along the Cuyahoga River as we did along the Grand. Price (1950 and 1958) found a goodly number of gomphines along the Maumee River and its tributaries in Northwestern Ohio; forms rare or nonexistant there were often common in our area, and *vice versa*.

Pollution of the Grand River has been measured and documented by the United States Environmental Protection Agency (1974) and doubtless had an impact on dragonfly populations. Odonate nymphs, however, do seem tolerant of a wide range of chemical and physical conditions as compared to other, more sensitive, insect groups (Hynes 1974 and Roback 1974).

Habitat-areas of the Grand River had distinctive dragonfly and damselfly populations with some overlap. The highest diversity indices (indicating similarity) of habitat were between lake-pond and transition and between tributary and upper river habitats. The river's transition area was slow-moving and pond-like with a fine substrate, while tributary and upper river had similar dimensions and surrounding area (small flowing streams in scarcely populated, often wooded areas).

Sometimes the overlap between habitat-areas was abrupt. This overlap was dramatically apparent at Harpersfield, where an artificial dam separated middle from transition areas. Water above dam was slow-moving and pond-like, while below dam were rocks and rapids, with a good flow of water approaching 80 cm/sec. *Gomphus exilis*, *Dromogomphus spinosus*, *Didymops transversa*, *Basiaeschna janata*, along with various libellulines, were found almost exclusively above dam. *Gomphus fraternus*, *Gomphus lineatifrons*, *Gomphus quadricolor*, and *Macromia illinoiensis* were found among the wave-beaten rocks and white water below.

We designated the various habitat-areas of the Grand River according to activity and/or abundance of odonate genera present. Tributary streams comprised the *Boyeria-Calopteryx-Cordulegaster* area. Upper river contained *Calopteryx*, along with scarcer but larger and more widely distributed *Hagenius* and *Nasiaeschna*. Transition area was the home of *Basiaeschna*, *Didymops*, and *Dromogomphus*. *Argia*, *Gomphus*, and *Hetaerina* were typical middle river denizens, while *Argia*, along with typical pond-dwellers *Enallagma* and *Libellula*, found a stronghold in the lower-mouth portion of the river. *Aeshna*, *Enallagma*, and *Libellula* were the most typical lake and pond genera.

Corbet (1962) stated that in certain river systems the more primitive dragonfly groups tended to be found nearest the river's source (tributary, typically high-elevation streams), while the more specialized groups tended to be found nearer the stream's mouth. This finding was to a certain extent true of the Grand River system. Families Petaluridae, Cordulegastridae, and Gomphi-

dae tended to be found concentrated upstream, in the tributary, upper, and middle portions of the river. Aeshnidae, Libellulidae, and Coenagrionidae tended to be found at downstream habitat-areas (lower and mouth) and at lakes and ponds in the watershed area. All habitat-areas tended to have a distinct as well as diverse dragonfly population, the most productive being lake-pond within the watershed, and middle river portion. Most diverse were tributary and upper river from the standpoint of families represented. Universal genera (*Argia* and *Enallagma*) were present, but no universal species.

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